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Final Work Plan
12686

Remedial Investigation – Feasibility Study City of Sturgis Well Field Sturgis, Michigan

Prepared for:

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FINAL WORK PLAN

CITY OF STURGIS WELL FIELD

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

INTRODUCTION

This Work Plan describes the scope of activities required to complete a Remedial Investigation/Feasibility Study (RI/FS) for the City of Sturgis, Michigan. The Work Plan includes a description of the problem, assessment of past investigations and information, a task-by-task description of the project activities, and a detailed budget and schedule. The State of Michigan Department of Natural Resources (MDNR) has requested that Warzyn Engineering Inc. of Madison, Wisconsin prepare this Work Plan. Warzyn and its subcontractors will be performing the tasks outlined in this plan. The revised detailed cost estimate for the RI/FS is presented in Table 1 and the project schedule is presented in Table 2. The project schedule has been modified so that Week 1 is approximately July 6, 1987.

Objective

The primary RI/FS objectives, as described in this Work Plan, are as follows:

- Determine the extent of contamination to the aquifer which provides the City of Sturgis' municipal water supply;
- Identify, if possible within the limits of this RI, the source(s) of the volatile organic compound (VOC) contamination of the aquifer and characterize the source(s) identified;
- Evaluate the threat posed by the contamination to the public health and welfare;
- Develop and recommend a remedial response(s) to reduce or eliminate the potential threat to public health and welfare;
- Identify alternate well field locations that may not be affected by the identified VOC contamination.

REMEDIAL INVESTIGATION (RI)

TASK 1 - PREVIOUS INVESTIGATIONS AND REMEDIAL ACTIONS

Background

The City of Sturgis provides water to nearly 10,000 city residents (see Figure 1 for the general location of the City of Sturgis). In addition, the City provides water to businesses, industries and service institutions. In 1982, the water supply wells consisted of 4 wells (Layne, Jackson, Kirsch and Lakeview wells) shown on Figure 1. During routine chemical testing of the municipal water supply in 1982, the Michigan Department of Public Health (MDPH) found that the water from two City wells, the Jackson and Layne Wells, were contaminated by two volatile organic compounds (VOCs), trichloroethene (TCE) and tetrachloroethene (PCE).

TCE and PCE are commonly used as degreasing or cleaning agents, and are used extensively in dry cleaning, metal fabrication and plastics manufacturing. The concentration of TCE increased substantially in the Jackson Well during the first year after it was identified (from 26 ug/L to 152 ug/L).

In August and September 1982, the State of Michigan Department of Public Health (MDPH) recommended that the City investigate the source of the VOCs, discontinue use of the two contaminated wells, and begin searching for a new well site. In October 1982, the City hired Gove Associates to investigate the TCE contamination in Sturgis in an effort to locate its source. Also, in October 1982, PCE was first detected in the Jackson Well. By December 1982, the City had begun investigating alternative water supply sites. In May 1983, Gove Associates issued its report concluding that they were unable to locate the source of TCE contamination through a limited groundwater investigation. Also during May, the City began increasing the pumping capacity of two other wells, the Lakeview well (located in the southeast portion of the City, see Figure 1) and the Kirsch Well (the western most well shown on Figure 1).

In July 1983, the City asked the residents to voluntarily limit their drinking water consumption. In November 1983, TCE was discovered at an industrial water supply well (Well No. R4 on Figures 1 and 2), located approximately 2000 ft northwest of contaminated City wells PW-1 and PW-2. In April 1984, the City began using water from a new well, the Oaklawn Well, located on the south side of the City. Pumpage was discontinued at the Jackson and Layne wells, and was increased in the Kirsch, Lakeview and Oaklawn Wells. In January 1985, TCE was detected at the Kirsch Well, located approximately 2700 ft west of the Jackson and Layne Wells. Since January 1985, the Jackson Well has been abandoned, the Layne Well has not been used, and the Kirsch Well pumpage has been significantly decreased. The City at present relies primarily on two wells located on the south and southeast sides of the City (the Oaklawn and Lakeview wells, respectively) to supply the majority of its municipal water requirements. However, during peak periods the Kirsch Well is used to provide up to 25 percent of the municipal water supply. Limited mixing of water from the Kirsch well is reported to occur with the other City water when this well is used.

Geology

Sturgis is located in an area of extensive glacial outwash approximately 1/2-mile to the south of a recessional moraine associated with the Sturgis-Kalamazoo Morainal System. According to logs from well locations and test borings, two thick sand and gravel units separated by a clay layer lie below the City. The lower sand and gravel unit is the aquifer utilized by the municipal and industrial water supply wells and is 80 to 120 ft thick. It is present from approximately 60 ft to 190 ft below ground surface. The base of the lower aquifer is formed by a thick lacustrine clay.

The top of the clay layer separating the two sand and gravel units is found at a depth of 50 to 60 ft and varies in thickness from 15 to 40 ft. This clay layer appears to be continuous throughout the northern and western portion of the City based on information obtained from individual well logs. The upper sand unit varies from 50 to 60 ft in thickness.

In this area of the state, 200 to 400 ft of glacial material overlie the Marshall Sandstone of the Osagean Series, and the Coldwater Shale of the Kinderhookian Series, which are both Mississippian in age (Western Michigan University, 1981).

Topography and Hydrology

Maximum topographic relief in the City is about 40 ft with topographic slope trending from northeast to south and southwest toward the Fawn River (see Figure 1). A chain of lakes is located to the north and northwest of the City. The lakes form the source of the Prairie River which flows to the northeast. To the south of the City, the Fawn River flows to the southwest and west. A surface water divide, located to the north and east of the City, follows the margin of the end moraine. Two intermittent surface streams are located to the southwest of the City and flow to the southwest. The Nye Drain, located south of the City, flows to the west.

Hydrogeology

The Sturgis municipal wells utilize a two aquifer system which consists of two sand and gravel deposits separated by a till deposit which acts as a confining layer. Municipal wells pump water from the lower aquifer. A limited number of monitoring wells installed in the study area are screened in both the upper and lower sand and gravel units. Static water levels for monitoring wells installed in the lower aquifer are slightly lower than in wells installed in the upper aquifer, suggesting a small downward gradient, although no well nests have been installed. In addition to groundwater recharge resulting from infiltrating precipitation, industrial effluent discharge contributes to groundwater recharge in relatively small areas in the northeastern portion of the City.

Regionally, in the absence of pumping, groundwater is assumed to flow from the northeast to the west and southwest in the vicinity of the City of Sturgis. This assumption is based on the location and flow direction of the Fawn River and general topographic slope. Published detailed studies of the area are unavailable. Gove and Associates, Inc. of Kalamazoo (1982), reported that groundwater flow is toward the west and southwest. However, their flow assumptions are also based on topographic trend and surface stream directions.

During the past three years, pumpage from the lower aquifer to the municipal water supply system varied from 2.2 to 2.6 million gallons per day (mgd), based on a monthly average. The location of the majority of pumpage has recently been shifted from the Kirsch Well, due to the TCE contamination recently observed in this well. Although the Kirsch Well is still in operation, its use has been reduced significantly over the past three years. Also during this three year period, the Jackson Well had been abandoned, and the Layne Well had been removed from service and abandoned (based on discussion with the City Engineer). Current water supply operations use the Lakeview and Oaklawn Wells to provide the majority of the City's water supply. The Kirsch Well is used only during peak periods. Undoubtedly, local variations in groundwater flow occur as a result of municipal pumpage. In addition, industrial wells in the northern and central portions of the City also use groundwater from the lower aquifer, which causes further impact on local groundwater flow. The historical pumping rates for the industrial users are unknown to date.

Socioeconomic

Approximately 10,000 people reside in the City of Sturgis and nearly all are supplied with municipal water. Businesses and industries located in the vicinity of the contaminated wells include dry cleaners, metal fabricators, plastics manufacturers, paper producers, printing establishments, other factories and a foundry, as reported by TechLaw (1984). Some of the factories and the foundry have been granted a license by MDNR to dispose of non-contact manufacturing effluent in gravel pits adjacent to their locations.

The City has, in the past, hired various consultants in an attempt to locate the source of the contamination and to locate alternate potable water supplies. The City has modified pumping schedules to avoid or eliminate the use of contaminated wells. City officials recognize that continued use of the Kirsch Well may produce water quality in excess of proposed drinking water standards and the potential threat to public health that would exist with continued use of the TCE/PCE contaminated wells. Little or no public concern has been expressed.

Previous Remedial Actions

To date, the remedial investigation actions include a study by Gove Associates who were unable to identify the source of contamination. The MDPH water sampling program, which initially identified the problem, has been continued through analysis of several samples between 1982 and 1986. In order to replace the loss of production of removing the Layne and Jackson wells from the system, the City installed the Oaklawn well. The City is also contemplating installation of another well to replace the Kirsch well.

An industry in the northern protion of the City had 3 of their 4 wells (Wells R1, R2 and R4 shown on Figure 2) affected by TCE and PCE. This problem area has been referred to as the W. Lafayette St. Area in MDNR's records. The industry responded by installing a new well north of the plant. Although the new well is clean, the industry is using carbon adsorption treatment for water which is used for consumption and as ingredient water in their manufacturing process (based on discussion with the plant engineer).

Assessment of Existing Information

Water samples had been collected from the City production wells since 1955 by the MDPH on an irregular basis. However, VOC analysis was first performed in June 1982 and VOCs were detected in samples from the Jackson and Layne Wells. Since then, the production wells remaining in use have been sampled at least on a yearly basis for VOCs and indicator parameters.

A rapid rise in TCE and PCE was noted in the Jackson and Layne Wells between 1982 and 1983. Between June 1982 and May 1983, TCE concentrations in the Jackson Well continuously increased (with the exception of the 8-20-82 sample) from 26 ug/L to 152 ug/L, while TCE at the Layne Well fluctuated between 2 ug/L and 43 ug/L during the same period. PCE was detected only at the Jackson Well and increased from a concentration of 1 ug/L to 3 ug/L between September 1982 and May 1983. Pumping at these wells was subsequently stopped.

No VOCs were detected at the Kirsch Well between May and December 1983. During this period the pumping of the Kirsch Well was increased to replace the lost production from the Layne and Jackson Wells. The Kirsch Well provided approximately 50% of the water supply by 1984. In January 1985, TCE was identified at the Kirsch Well, 8 months after discontinuing use of the Layne and Jackson Wells. The concentration has fluctuated between 1 ug/L and 6 ug/L at the Kirsch Well between January 1985 and May 1986. Concentrations of VOCs appear to have been moved from one well to another as the center of pumping was shifted from the Jackson/Layne Wells to the Kirsch Well.

The concentrations of inorganic chemical constituents in individual municipal wells have remained relatively unchanged through time. However, the chemistry of the groundwater in wells in the central part of the City (the Jackson, Layne and Kirsch Wells) differs somewhat from wells in the southern part of the City (the Lakeview and Oaklawn Wells). Chloride (13 to 20 mg/L), nitrate (38 to 51 mg/L), sulfate (38 to 51 mg/L) and hardness (315 to 319 mg/L) concentrations are higher in the central wells than they are in the southern wells (Cl: 4 to 8 mg/L; NO_3: 0 to 1 mg/L; SO_4: 22 to 32 mg/L; hardness:

278 to 309 mg/L). Other inorganic parameters (pH, conductivity, alkalinity, calcium, magnesium, sodium and potassium) are similar at the respective locations.

In addition to TCE and PCE, MDPH has identified bromoform and other trihalomethanes in the water supply. It is assumed that these compounds are the result of in-line chlorination of the drinking water supply. However, these compounds will be included in the RI analysis. No other priority pollutants have been detected to date.

Data Requirements

Based on the review of the existing data, the following data requirements have been identified in order to identify potential source areas, extent of contamination, and to evaluate potential remedial actions:

1. Evaluation of potential source areas through:

   a. Survey of existing large industries in the area to determine whether VOCs are used or have been used in the past, and what storage, handling and disposal practices are or have been used in the past;

   b. Preliminary groundwater flow modeling to evaluate possible source areas by estimating fluctuations in groundwater flow directions due to changes in pumping.

   c. Evaluation of potential source areas through the use of a remote sensing technique (soil gas survey) to determine whether VOCs may be present in the subsurface;

   d. Direct soil and water sampling and analysis within potential source areas to identify the presence of VOCs and estimate the mass of VOCs present in the unsaturated zone.

2. Further characterization of the geology and hydrogeology of the area including vertical and horizontal components of flow direction under existing pumping conditions, and the hydraulic properties controlling flow.

3. Information on groundwater quality within the principal aquifer and within the overlying units to characterize the vertical and horizontal contaminant distribution.

4. A location and elevation survey of sampling and monitoring wells.

TASK 2 - PLANS AND MANAGEMENT

This task is for the preparation of planning documents necessary for the performance of the RI and FS. The plans are considered working documents and may require modification in the field during the RI/FS. The documents developed in this task will be approved by Michigan Department of Natural Resources (MDNR) and U.S. Environmental Protection Agency (U.S. EPA), as appropriate, before work on subsequent tasks or subtasks relying on them can occur. Warzyn Engineering Inc. will perform document development.

Subtask 2.1 - Work Plan Preparation

This Work Plan provides detailed descriptions of tasks to be performed during the Sturgis Well Field RI/FS. This Work Plan was prepared based upon a review of existing site and regional data (Task 1), discussions with representatives of MDNR, MDPH, and representatives of the City, and a site visit by Warzyn personnel.

U.S. EPA guidance documents for performance of Remedial Investigations and Feasibility Studies were considered when developing this document. In addition to a detailed technical description of tasks to be performed in the Sturgis Well Field RI/FS, a projected cost estimate for the investigation and project timetable are also included (see Tables 1 and 2, respectively).

Review comments on the Draft Work Plan from MDNR, MDPH, U.S. EPA and the City have been considered and incorporated into this Final Work Plan.

Subtask 2.2 - Quality Assurance Project Plan

The Quality Assurance Project Plan will be developed to cover both on and off-site activities. The plan will cover data collection, reduction, and analyses, and address analytical testing, surveying, soil testing, drilling, and sampling activities. Development of the plan will be in accordance with applicable U.S. EPA guidance documents.

It is assumed that review by the U.S. EPA Quality Assurance Office will result in minimal changes to the draft document.

Subtask 2.3 - Sampling Plan

Individual Sampling Plans will be developed to cover the sampling and data gathering efforts described in Phase I and Phase II of this Work Plan. Preparation of the Phase II Sampling Plan will be completed after developing the scope of work for Phase II. Specifically, the Sampling Plans will address the following topics:

- Sample types, locations and costs
- Sampling equipment and procedures
- Sampling QA/QC
- Sample handling and preservation
- Chain of custody procedures
- Sample documentation
- Sample shipping
- Analytical arrangements
- Sampling team organization, responsibilities and training
- Scheduling
- Investigation types and methods

The Sampling Plans will be developed in accordance with applicable U.S. EPA guidance documents. Review comments from the MDNR and U.S. EPA on the Draft Sampling Plans will be considered and incorporated into the Final Sampling Plans. U.S. EPA will solicit comments from ATSDR to the extent practicable, that their data needs for conducting a health assessment at the site are met within the scope of the Sampling Plan.

Subtask 2.4 - Health and Safety Plan

A Site Health and Safety Plan will be prepared to protect the investigation team and nearby residents from potential hazards which may be present as a result of on-site investigation activities. The Plan will:

- Address applicable regulatory requirements and detail personnel responsibilities, protective equipment, procedures and protocols, decontamination, training and medical surveillance;
- Identify problems or hazards that may be encountered and their solutions;
- Indicate procedures for protecting third parties, if necessary, such as residents, visitors and transient motorists; and
- Take into consideration facility conditions and be consistent with:
  - Section 111(c) (6) of CERCLA
  - EPA Order 1440.1 - Respiratory Protection
  - EPA Order 1440.3 - Health and Safety Requirement for Employees Engaged in Field Activities
  - EPA Occupational Health and Safety Manual
  - EPA Interim Standard Operating Safety Procedures and other EPA guidance as developed by EPA.

The Health and Safety Plan will include an assessment to determine if there are portions of the site or specific investigation activities that present potentially hazardous exposure levels in the air or through dermal contact. Investigation activities will be designed to minimize hazards to the investigating team.

In conducting the health and safety assessement, available information on the site will be examined and reviewed to identify potential hazards. Such information will be used in selecting and implementing procedures that provide nearby residents and investigators with adequate warnings and safeguards. The Health and Safety Plan will specify the following:

- Protective clothing and respiratory equipment to be worn;
- Air monitoring to be performed;
- Action levels at which respiratory protection will be upgraded;
- Decontamination procedures.

The Health and Safety Plan will be developed in accordance with applicable U.S. EPA guidance documents and requirements. Applicable OSHA, MOSHA and NIOSH requirements will be followed. Review comments from MDNR and U.S. EPA on the Draft Health and Safety Plan will be considered and incorporated into the Final Health and Safety Plan. The Health and Safety Plan will be updated for the Phase II investigation based on results of Phase I and the scope of the Phase II investigation.

Subtask 2.5 - Notification of State ARARs

When approximately 25% of the RI is completed the State will notify the Contractor and U.S. EPA of applicable or relevant and appropriate requirements (ARARs) of State environmental or facility siting laws at the site. The scope of the RI will be evaluated and, if necessary, adjusted to achieve compliance with State ARARs. As appropriate throughout the RI/FS, the State will update the identified State ARARs.

TASK 3 - PRELIMINARY EVALUATION OF POTENTIAL SOURCES

Subtask 3.1 - Industrial Site Survey

There are numerous potential source areas of TCE and PCE within the City of Sturgis identified in the TechLaw report (1984). Based on the presumed groundwater flow direction and the observed contaminant distribution, the likely area for potential source areas has been limited to an area approximately north of Chicago Road. Within this area there are numerous industries both operating and closed which may have used TCE or other solvents in the past. During the site investigation phase, field sampling will be conducted on many of these potential source areas to determine whether individual sites are acting as a source of VOCs. Prior to initiating the site investigation at the relatively large plants, a plant survey will be conducted with the cooperation of each industry. The intent of the surveys is to view the operations of the plants, and determine where solvents have been stored, used or disposed on the plant grounds, both under current operations and in the past.

The surveys are currently planned to be conducted through the Sturgis Foundry, the Kirsch Company, Kirsch Municipal Airport, the Frye Printing Company, United Paper, Ross Laboratories and the Bandholtz Paint Manufacturing Company. Others may be included based on discussions with local residents. The site surveys will be conducted by the project engineer and the hydrogeologist who will be conducting the site investigation.

One or more representatives from MDNR will be present during the site surveys. A brief technical memorandum will be prepared summarizing the observations made during each plant survey.

Warzyn will perform Subtask 3.1. Costs assumptions for this task are as follows:

- The surveys of Sturgis Foundry, Kirsch Municipal Airport, Kirsch Company, Frye Printing Company, United Paper, Ross Laboratories and Bandholtz Paint Manufacturing Company will require 1 two day trip;
- The DNR will arrange with the industries for the site surveys.

Subtask 3.2 - Preliminary Model Development

A preliminary estimate of groundwater flow directions through groundwater flow modeling will be developed to identify areas which may contain potential sources. A preliminary groundwater flow model will be developed, using existing geologic and hydrogeologic data. The primary hydrogeologic data will be the results from two pumping tests and several years of pumping rate records. The purposes for this preliminary model will be:

- To identify possible groundwater flow directions under variable pumping rates;
- To outline plausible contaminant source areas within the zones of capture of the Layne and Jackson wells, and the Kirsch well prior to and during the time each well was contaminated;
- To determine whether the same source could possibly account for the contaminantion at the Layne/Jackson Well, the Kirsch Well and the northwest industry wells.
- To identify the aquifer parameters to which the simulated groundwater flow direction and velocity are most sensitive. Knowledge of these sensitivities will allow the investigation to focus on those areas or parameters that will control potential remedial actions and the potential changes in contamination distribution under various alternative pumping scenarios.

The model to be used is intended to be a quasi three dimensional (3-D) model to simulate flow within and between aquifers. The USGS modular 3-D model is planned for use. Several years of city pumping records prior to 1982, before the contamination was identified, will be used in the transient simulation.

Industry pumping wells (Ross Labs and Sturgis Foundry) will be included in the model. Pumping rates will be as obtained from the industry or estimated based on indirect methods (e.g., metered sewer outfall). Simulated water table and potentiometric maps will be developed for several points in time to map the zone of influence of each well through time. The sensitivity of the boundary conditions, upper and lower aquifer transmissivity and vertical hydraulic resistance of the semi-confining unit will be evaluated on a preliminary basis. Contaminant transport modeling is not planned at this preliminary level. A brief technical memorandum will be prepared to summarize the model results.

Warzyn will perform this subtask.

TASK 4 - PHASE I SITE INVESTIGATION

The Phase I Site Investigation will consist primarily of well installation, water quality sampling, aquifer testing and the support activities necessary to select the well locations.

Information on the geologic and hydrogeologic conditions within the area is available through municipal water supply, exploratory and production well data, and pumping test data.

There is little or no information on the vertical and horizontal distribution of groundwater contamination (other than the municipal wells), or potential sources. Therefore, the field investigation will rely on sampling and on-site chemical analysis throughout the Phase I Investigation to allow continual re-evaluation of monitoring well locations. A soil gas survey will be utilized to evaluate several potential sources. Water quality sampling and analysis during drilling will aid in identifying the vertical and horizontal contaminant distribution to aid in locating the remaining wells to be installed in Phase I.

The horizontal and vertical placement of monitoring wells will be based on the following criteria:

- The vertical and horizontal placement of the municipal and industrial pumping wells;
- The locations of potential contaminant sources identified through present and past industrial practices in the area;
- The results of the preliminary evaluation of potential sources (Task 3);
- The results of a soil gas survey with in-field sample analyses;
- The results of water quality sampling during drilling with in field analyses.

Eleven monitoring wells at seven locations are planned based on the first two criteria regardless of field sampling and analytical results. Locations for these wells are shown on Figure 2. Approximately seven other wells will be located specifically on the results of the soil gas survey and in-field groundwater quality sampling and analysis results found while drilling. These wells are intended to be used primarily to identify and characterize potential containment source areas and the resultant plume. Therefore, exact locations and depths of wells have not been determined for this Work Plan.

The soil gas survey will be conducted concurrent with the drilling program to make the most efficient use of both the personnel and the field GC (gas chromotograph). The team leader will be the project hydrogeologist and will be making field decisions in close cooperation with the MDNR and the Warzyn project manager in selecting the additional well locations. Although the following task descriptions do not identify exact sampling locations, the rationale for selecting soil gas sampling and well locations is outlined.

TASK 4.1 - SITE INVESTIGATION PREPARATION

In preparation for the field GC analysis of soil gas and water quality samples using a lab GC, a short method development and calibration study will be conducted with the GC in the lab. This study will establish the most efficient and effective methods (i.e., detection limits, temperature program, column type and standards preparation) to detect the primary compounds of interest, TCE and PCE. This effort will require approximately 3 days of the lab GC and operator time. The product from this study will be written standard operating procedures for the on site GC analysis. A detailed description of the field analysis method will be included in the QAPP (Subtask 2.2).

A site trailer (10 ft by 40 ft) will be set up as a base of operations for the project. This trailer will house the on-site lab in one room and a site operations quarters in a separate room. The trailer is planned to be set up within the fenced compound of the City Yards, with the permission of the City. This fenced compound would provide the security needed for the on-site equipment. Storage of well materials, sample bottles, and sample coolers will be discussed and established with the City's cooperation.

The location for steam cleaning well pipe, screen and the drilling rigs prior to site operations will be discussed with the City. It is assumed that a suitable location, such as the sanitary district sludge beds, can be agreed upon with the City where a small sump with a direct discharge to the City storm or sanitary sewer can be arranged. This would not require construction of a decontamination pad. Steam cleaning the drilling rigs between holes will be conducted at each individual well location. The steam cleaning water from the drill rigs is anticipated to have very low or no contaminants because of the low concentrations present in the groundwater. Therefore, the steam cleaner water discharge will be contained only so as to not create a nuisance. At sites where significant concentrations are observed in the split spoon samples, through HNu or OVA screening, water will be contained and disposed of as directed by the MDNR. It is anticipated this will consist of attempting to contain the water and disposal to the City sanitary sewer, such as steam cleaning at the sanitary district sludge beds at the sewerage treatment plant.

Assumptions for the cost for this task are as follows:

- A 10 by 40 ft site trailer will be maintained on site throughout the duration of field investigation.
- The set up and calibration of the field GC for the field investigation will be accomplished through a 2 1/2-day period immediately prior to initiation of Task 4.2 and 4.3.
- The City will allow the site trailer within the confines of the City Yards and that a suitable secure location can be identified for storage of the well materials and other bulky items needed for the investigation.
- There is a relatively easy access for installation of electric and phone utility hookups.

Warzyn Engineering will perform Subtask 4.1.

Subtask 4.2 - Existing Well Sampling

Selected existing monitoring wells (10 total: GW-1, 2, 4, 6, 7, 8,; MW-3A, 3C, 4, 5), test wells (2 total: TW-83A, TW-84), and production wells (11 total: 5 city wells, 5 Ross Lab's and Sturgis Foundry) will be sampled for water quality. The purpose for this sampling and analysis is to provide information on existing site conditions at the beginning of the study. CLP analyses for VOCs will be conducted by low level GC/MS through a SAS (Special Analytical Services) request to verify the compounds to be analyzed by the on-site GC during the soil gas and well drilling and sampling tasks. Samples will also be analyzed for the following water quality parameters: pH, conductivity, calcium, magnesium, alkalinity, sodium, potassium, sulfate, chloride, nitrate-nitrogen, total Kjeldahl nitrogen and total organic carbon.

Prior to sampling, the wells will be pumped (using MDNR's Johnson Keck submersible) or bailed until pH and conductivity stabilizes. It is assumed this can be achieved by removal of three well volumes of water. The samples will be collected from the sample tap at production wells and from the pump or a stainless steel bottom loading bailer at the monitoring and test wells. Water levels in each well will also be measured as part of the assessment of general hydrogeologic conditions. The water level measurements will be taken prior to sampling.

Assumptions for developing costs for the existing well monitoring are:

- 23 monitoring and water supply wells will be sampled, along with three duplicates, three field blanks, two trip blanks and four matrix spikes, for a total of 35 samples;
- Sampling and water level measurements will require two crews of two field personnel to collect samples, one person to handle sample documentation and shipping, and a laboratory technician to perform the on-site analysis;

- Sampling and water level measurement will occur concurrently with drilling and will require four 12-hour days;
- Existing wells are suitable for sampling;
- Level D protection will be required;
- HNu monitoring will be required during sampling;
- The MDNR will obtain access to the existing wells for sampling.

Warzyn, Engineers International (EI) and Johnson-Malhotra (JM) will perform this subtask.

Subtask 4.3 - Soil Gas Survey

Soil gas sampling with onsite analysis will be conducted in order to help identify potential source areas and map the VOC plume that may be present at the water table surface in the immediate area of a potential source. Results of these on-site analyses will be used to guide the selection of well locations.

The scope of the soil gas survey at each individual potential source area will be determined based on the size of the facility, the type of operation conducted (presently or in the past) at the site and the results of the inplant survey (where conducted; Task 3).

Soil gas sampling will be conducted over a 10 day period at locations where TCE and/or PCE are believed to be (or have been) used. Figure 3 and Table 3 show the intended locations and estimated number of soil gas sampling points. The facilities to be sampled include dry cleaners, paint and solvent distributors, metal fabricators, a food processor and paper and plastic manufacturers. The estimated number of soil gas samples at each location was based on the size of the facility being monitored.

TABLE 3

Proposed Soil Gas Sampling Sites
Sturgis Well Field RI/FS

Location No.	Name/Type of Business	Total Number of Samples
1	Sturgis Tool and Die, Inc. 817 Broadus; 313 Susan Ct. (Metal Fabrication)	2
2	Kirsch Company 309 Prospect, 400 E. Hatch (Metal Fabrication)	15
3	Diamond Gear and Engineering 203 Ulm Street (Metal Fabrication)	3
4	Losinski Mold-Tool and Die 925 Clay Street (Metal Fabrication)	2
5	Sturgis Foundry Corporation 800 and 100 W. West St. (Foundry)	15
6	Parma Tube Corporation and Parma Tube lot behind 1008 W. Progress St. (Metal Fabrication)	3
7	Wade Electrical Products Company 211 Jacob St. (Electrical Parts, Solvent Distribution)	5
8	City Park West Power Plant (Possible former disposal site) 200 Blk. W. Chicago Road	4
9	Transogram-Midwest, Inc. 501 Jacob Street (Plastics and Metal Fabrication)	4
10	J&W Products, Inc. 807 W. West Street (Metal Fabrication)	3
11	Sturgis Electric Motor Service 703 N. Centerville Road (Motor repairs, metalizing)	2

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Location No.	Name/Type of Business	Total Number of Samples
12	United Paper Company 1 United Drive (Paper Products)	5
13	Bandholtz Paint Mfg. Co. 121 N. Nottawa St. 106 Pleasant Avenue (Paints and Solvents)	9
14	Area of McKee and Centerville Rd Numerous Metal Fabricators	10
	Total Number of Samples	82

A total of 82 soil gas samples are anticipated to be collected over the ten day period for the purpose of evaluation of potential sources. If potential contaminant sources are located, additional soil gas samples may be collected to aid in well locations. The additional samples may also help to delineate the direction of the contaminant plume. These additional samples will be collected after completion of the planned survey, if time allows, or as an additional task. Soil gas sampling along the railroad tracks or at the Kirsch Municipal Airport are not currently planned. However, there are several planned soil gas sample locations adjacent to or in an apparent downgradient location. If results of samples indicate an area along the railroad and/or the airport is a potential source area, some of the discretionary samples will be collected along the railroad lines or at the airport.

Soil gas sampling will consist of driving a probe to a depth of approximately 3 ft, purging the sampling probe and tubes and collecting a sample in a glass gas sampling vial. The sample will be returned to the onsite GC for analysis. Sample blanks will be collected between each facility being surveyed. Results of the soil gas analyses will be plotted and used to evaluate each facility as a potential source, to locate additional soil gas samples if needed on the property, and to identify areas where direct groundwater sampling is required. Soil gas sample locations will also be dependent on the results of water quality analyses of samples collected during drilling.

Assumptions for developing costs for the soil gas sampling program are as follows:

- Soil gas sampling will be conducted and analyzed over a 10 day period;
- Two field personnel will be required for soil gas sampling over the 10 day period;

- An on site GC operator will be shared with the water quality sampling and analyses on a half-time basis;
- HNu monitoring will be required during sampling;
- Level D site safety will be required during sampling;

Warzyn and JM will perform Subtask 4.3.

Subtask 4.4 - Well Drilling

Groundwater monitoring wells will be installed to collect groundwater quality samples, groundwater levels and to perform hydraulic conductivity testing during this investigation. Eighteen wells for a total of 1800 feet of drilling and well installation are planned for the initial field investigation phase. Of this total, 11 wells at 7 locations, shown on Figure 2, are planned for determining groundwater flow directions (vertical and horizontal) in both the upper and lower aquifers and initial water quality sampling during drilling. The rationale for these locations is presented in Table 4. The seven remaining wells are intended to be located based on the results of the soil gas sampling program, the preliminary testing of existing monitoring wells, and analyses of water quality samples collected during well drilling. These wells will be located to help characterize potential source areas and migration routes identified through the industrial site surveys (Subtask 3.1), the soil gas survey (Subtask 4.3) and on-site analysis during drilling.

Shallow borings will be drilled using 4 1/4 in. I.D. hollow stem augers. Upon completion, a well will be installed using a 10 ft stainless steel screen and galvanized steel riser pipe to complete the well. Each well will be backfilled using standard proceedures, and a protective casing will be installed. Figure 4 shows the proposed shallow well construction details.

TABLE 4

Proposed Well Locations and Their Rationale
Sturgis Well Field RI/FS

Well No.1	Total Drilling (ft)	Rationale
W-1S, D*	200	To examine water quality on the former site of a potential TCE user.
W-2S, ~~D~~	~~200~~ 50	To characterize groundwater flow and water quality to the east of the contaminated power plant (Jackson and Layne) wells in the vicinity of a potential source area.
W-3S	50	With TW-83A, will examine groundwater flow parameters at a location between industrial pumping wells (R-wells) and the power plant wells.
W-4S	50	To augment an existing monitoring well installed by Gove Associates, Inc. W-4S will monitor groundwater flow in the upper aquifer.
W-5D	150	To augment an existing monitoring well installed by Gove Associates, Inc., W-5D will monitor groundwater flow and water quality in the lower aquifer.
W-6S, D	200	To characterize general water quality and vertical hydraulic gradients to the northeast of contaminated municipal Well PW-3.

TABLE 4
(Continued)

W-7S, D	200	To examine water quality and ground-water flow to the west of a series of contaminated industrial water supply wells in an industrial park with several potential source areas.
Total with Planned Locations	1050	
Discretionary		
W-8~~S~~,D	200	
W-9~~S~~,D	200	
W-10~~S~~,D	200	
W-11~~D~~	150	
Total Discretionary	1800	

1. Nested wells designated as

   S - Shallow well in the upper aquifer - 50 feet deep
   D - Deep well in the lower aquifer - 150 feet deep

2. Total discretionary drilling footage is based on unit costs for drilling and well placement specified. Actual number and depth of wells implemented in the field may be different.

The deep borings will be performed and sampled with 4 1/4 inch I.D. hollow stem augers to approximately 60 ft, which is estimated to be approximately five ft into the semi-confining clay layer at depth. The hollow stem augers will be removed, and a temporary 6 inch casing will then be installed and sealed into the clay layer, using bentonite pellets to prevent possible cross contamination between the upper and lower aquifer.

The borings will be completed using clear water rotary drilling methods while advancing 5 inch casing, telescoped within the 6 inch casing. Four inch casing will be telescoped within the 5 inch casing, if necessary, to complete the borehole. If the clay layer is not encountered within 60 ft from the ground surface, a 6 inch casing will be set, and drilling will be completed as specified above. Upon completion of the well, the temporary casing will be removed.

Due to the possibility of auger loss as a result of drilling depth or running sand, MDNR has accepted responsibility for auger replacement costs, costs associated with abandonment of the borehole, additional labor costs and costs of other materials associated with attempted auger recovery and borehole abandonment. These costs are not included in the present budget.

Split spoon soil sampling will be done at the deepest well at each loction on a 5-ft inverval to a depth of 25 ft, and on a 10-ft interval to the bottom of the borehole or at changes in soil type. At locations where both a shallow and a deep well are present, the shallow well will be earth drilled. Water used for drilling and well installation will be obtained from either the Oaklawn or

Lakeview municipal wells located on the south side of the City. These wells are not located within the contaminated portion of the aquifer.

Water quality samples will be collected during drilling of the 18 wells listed in Table 4, from selected locations through both the upper and lower aquifers, to help identify the plume distribution prior to setting the well screen. These samples will be analyzed using an on-site GC. Results will be used to help identify the vertical and horizontal plume distribution so that the well screen can be placed. Further, the horizontal location of additional wells can be placed based on an improving knowledge of VOC concentration distribution. Therefore, the results of the on-site analyses are intended to help determine the optimum screen location, and may be used to locate additional wells.

Groundwater samples are intended to be collected from coarse grained zones within the fine grained soil unit, and on an approximate 10-ft interval within the primary and upper aquifers. This is assumed to result in eight samples per deep well, and one sample from each of the shallow wells, for a total of 81 samples. Eight duplicates and eight blanks will also be analyzed. The analysis method is intended to be on a head-space sample using a dual detector (PID/HECD) on a lab model GC. Two water quality samples will be collected from each sampling depth, a VOA vial with a 1/2 in. head space sample for on-site analysis and a full VOA vial for potential CLP lab analysis. Thirty-eight (38) samples are planned to be submitted for lab low level GC/MS analysis, SAS, for confirmation of the compounds detected. Samples to be sent for lab analysis will be selected as a representative range of results based on the on-site analysis, and will include three samples for VOCs detected in each contaminated boring, and one sample for each boring where VOCs are not detected. Sampling methods will consist of driving a galvanized steel drive point ahead of the casing. If driving the point proves not to be practical, an alternate method will be used. This alternate method will consist of driving the point to seat it in the soil, and setting a packer in the casing. The water within the drive point would then be purged to remove three well volumes before sample collection.

Each of the existing deep monitor wells and each deep well drilled during this study will be logged using a natural gamma ray logging tool. A Mount Sopris 1000C Unit with the stratigraphic gamma ray tool will be used. The gamma ray log will provide information on the clay content of the formations penetrated and will be used in selecting the vertical position of the well screen. The geologist on each drill rig will run the log when the borehole has been drilled to its terminus. The vertical position of the well installed at each well nest will be selected based on the results of the on-site water quality analyses and the geophysical results. At locations where no contaminants are identified by the on site analyses, the intent will be to install a well within the principal aquifer for water level monitoring. At those wells where on site analyses identify contaminants, the well screen would be placed within the zone where the highest concentration was identified. Nested wells are intended to be installed at several locations in addition to those shown on Figure 2. Locations for these well nests, and the number and vertical positions of the wells within each nest, will be determined based on the soil gas survey results, the geophysical logging and the results of the on site water quality analysis.

Well construction will be as shown in Figures 4 and 5. Flush joint threaded galvanized steel well casing with a 10 ft. stainless steel riser pipe and stainless steel screen will be used for each piezometer. The stainless steel riser pipe will not be required for wells that intersect the water table. Wells extending into the primary aquifer will be double cased, where the outer casing will be sealed in the clay (if present) to reduce potential for cross contamination between aquifers during drilling. Water table wells will use 10 ft well screens, while piezometers will use 5 foot screens. Well development will be completed using air development in the deep wells. A bailer will be used in shallow wells because sufficient submergence of an air line is not capable in the water table wells. Water will be produced from the wells until it is visually clear, and on-site pH and conductivity measurements stabilize.

Purge water from well development will be contained if an immiscible oil fraction is present or HNu readings indicate headspace concentrations above 5 ppm. Cuttings from the drilling operation will be contained if they are found to be contaminated through HNu screening (headspace readings above 5 ppm). Uncontaminated cuttings will be drummed and removed from the sites where on-site disposal may cause aesthetic problems. These cuttings will be disposed of off-site. This off-site disposal will be coordinated with the City. Disposal of contaminated cuttings and purge water, however, will be the responsibility of MDNR and/or U.S. EPA.

Assumptions for developing costs for this task are as follows:

- 18 wells at 11 locations are planned to be installed;
- 1800 ft of drilling is planned to be conducted; 900 ft using clear water and casing and 900 ft using hollow stem augers;
- Drilling will require 40 field days for three drilling rigs plus 8 days of travel;
- The field crew will consist of three geologists, one site safety officer (SSO) (between three drilling rigs), an on-site GC operator and a team leader on-site. Costs for the drilling crews are included in the boring/installation costs;
- Uncontaminated drilling cuttings will be hauled by a construction contractor to an off-site location coordinated with the City;
- 50 - 55 gal. drums will be required to contain cuttings and contaminated purge water;
- 90% of the drilling will be done in Level D protection, 10% in Level C protection;
- HNu monitoring will be done by the site geologist or the SSO for site safety;
- 81 water quality samples will be collected and analyzed during drilling, plus eight blanks and eight duplicates (97 total);
- 38 of the water quality samples analyzed on-site may be submitted for lab GC/MS analysis, with four duplicates and three blanks (45 total);

Warzyn, Engineers International (EI), and Exploration Technology Inc. (ETI) will perform Subtask 4.4.

Subtask 4.5 - Surface Water And Sediment Investigation

A total of eight surface water and eight sediment samples will be collected from a gravel pit, a disposal pit and two non-contact effluent discharge points in the potential source area(s) to determine if TCE and/or PCE have been released at the respective locations. These locations include effluent discharge points at the Sturgis Foundry and Kirsch Company, a gravel pit at Ross Laboratories and a possible pit located between Sturgis Foundry and the

Parma Tube Corporation. The distribution of samples between the four locations will be based on results of the industrial site surveys and will be approved by the MDNR project manager.

Surface water samples will be collected using stainless steel sampling equipment. Sediment samples will be collected using a hand corer and will be representative of the sediment at that location.

Surface water samples will be analyzed for pH and conductivity in the field and submitted to the CLP for analysis of volatiles by low level GC/MS, SAS. Sediment samples will also be analyzed by the CLP for volatiles by GC/MS.

Details of the sample collection methods and protocols will be stated in the Sampling Plan (Subtask 2.2). Sampling of the specified surface water and sediment locations will occur concurrently with the collection of the existing well samples (Subtask 4.2).

Surface water/sediment costs were estimated based on the following assumptions:

- Sampling will require two people, one person to collect samples and one to assist in sample preparation. Sample collection can be accomplished in two 12-hour days;
- Site safety monitoring will be conducted using an HNu;
- Water and sediment samples will contain low concentration of contaminants;
- Analysis will consist of a maximum of eight surface water samples, eight sediment samples, one duplicate of each media, one sampling blank, one trip blank and two matrix spikes of each media, for a total of 13 water and 13 sediment samples;
- Sampling will occur simultaneously with the existing well sampling (Subtask 4.2).

Warzyn and JM will perform this subtask.

Subtask 4.6 - Groundwater Sampling and Aquifer Testing

In addition to the on-site sampling performed in Subtasks 4.2, 4.3 and 4.4, 18 monitoring wells (installed during Subtask 4.4), 17 pre-existing monitoring wells, three test wells and eleven production wells will be sampled per round during two rounds of groundwater sampling. These samples are anticipated to form the basis for the RI analysis including source identification, extent of contamination, determination of the mass of contaminants present and the evaluation of remedial action alternatives. Therefore, these sample results will be handled and analyzed using U.S. EPA chain of custody documentation and procedures.

MDNR's submersible pump with a packer is planned to be used for deep monitoring well sampling. The packer will be set in the stainless steel riser above the screen and the pump used to purge and sample the well. A stainless steel bailer will be used in the shallow wells where the water intersects the screen. Prior to sampling, each well will be purged to remove a minimum of three volumes within the sampling zone (e.g., the zone below the packer in the deep wells). Production wells will be sampled from the well head sampling tap. Purging and sampling equipment will be decontaminated before reuse using a TSP wash and clean water rinse. Water purged from the wells will be collected and disposed to the City sewer. Conductivity, temperature and pH of all samples will be measured by the sampling team. Samples will be preserved (as specified in Subtask 2.2 - QAPP) and shipped on ice to the CLP laboratory daily. Groundwater samples will be analyzed for VOCs and general water quality parameters listed below:

Volatiles	Alkalinity
pH (field)	Sulfate
Conductivity (field)	Chloride
Calcium	Nitrate-Nitrogen
Magnesium	Total Kjeldahl Nitrogen
Sodium	Total Organic Carbon
Potassium	

The VOCs analysis is intended to be done by low level GC/MS (through a SAS) on the samples.

In addition to the above parameters, 10 Round One samples will be collected for complete HSL scan. These 10 samples will be chosen based on field analyses of samples, and will be submitted to the CLP for analysis. Detection limits for HSL compounds will be determined by Routine Analytical Services (RAS).

Round One groundwater sampling will occur no sooner than one month after completion of well installation and development. This time is intended to allow the wells to stabilize after well development. Round Two groundwater sampling will occur approximately six months after Round One sampling, subsequent to the Interim RI Analysis and Technical Memorandum (Task 4.9).

Hydraulic conductivity tests will be conducted on 20 wells including some water table wells and piezometers. The preferred test method, to be used in the piezometers, will be the use of air pressure to provide additional head within the well, and measuring response, with a pressure transducer. This method cannot be used on the water table wells, because a portion of the screen is above the water table and air pressure would be lost through the screen. Therefore, tests are to be performed in water table wells by removing a slug of water from the well and measuring recovery through the use of a pressure transducer and data logger. The data that is collected will be used to calculate the hydraulic conductivity of the aquifer. These tests will be conducted concurrently with the first round of this groundwater sampling program, and wells will be tested after sampling has occurred. Recovery of the wells is not anticipated to be a problem, although water levels at the time of the test will be compared to those prior to sampling to confirm recovery has occurred. Determination of wells to be tested will be made jointly by the Warzyn hydrogeologist and the MDNR geologist upon review of the well installation data and boring logs.

The following assumptions were used in developing the costs for this subtask:

- Each round of water quality sampling will require a six person team. Two teams of two people will collect the samples, one person will be responsible for sample preparation, and one person will provide chain of custody documentation and handle sample shipment;
- Each round of sampling will require seven-12 hour days plus two days of travel;
- Sampling will be conducted at Level D. Work at Levels C or B is not anticipated and would be considered out of the budget scope;
- 49 groundwater, 5 duplicate, 5 blank samples, 3 trip blanks and matrix spikes (65 total) will be collected and submitted to the CLP for analysis of VOCs and general water quality parameters;
- A hydrogeologist will conduct 20 hydraulic conductivity tests, and testing will take four-12 hour days;
- Groundwater samples will be of low concentration;
- Continuous HNu monitoring will be performed during purging and sampling.

Warzyn, JM and EI will perform this subtask.

Subtask 4.7 - Groundwater Level Monitoring

The RI work plan was developed under the assumption that groundwater flow is toward the southwest. This assumption was based on the limited data available on water levels. Therefore, groundwater levels will be measured to determine vertical and horizontal groundwater hydraulic gradients at the site.

At the completion of the well installation program, water levels will be measured at on-site wells. Water levels will also be measured concurrent with each groundwater sampling effort. Four additional rounds of water levels will be collected during the course of the RI to record fluctuations in water levels in response to pumping and seasonal changes. The resulting water levels will be useful in flow model calibration and estimating probable changes in migration. Water levels will be measured using a fiberglass tape and sounding device or an electronic water level indicator.

Costs for the above subtask were developed assuming:

- Four separate sets of water levels will be measured between the completion of the monitoring well network and the preparation of the RI report;
- One person will be required for one 12-hour day for travel to the site and measurement of each set of levels (total of 48 hours);
- Personal Protection Level D is adequate for monitoring.

Warzyn will coordinate JM's performance of this subtask.

Subtask 4.8 - Location and Elevation Survey

A location and elevation survey of monitoring and production wells will be performed by Johnson-Malhotra (JM) during the site investigation. The location and elevation survey will include other pertinent site features which may affect groundwater flow or contaminant distribution, such as surface water bodies and specific contaminant source areas. Warzyn will coordinate JM's performance of this subtask.

Subtask 4.9 - Interim RI Analysis and Technical Memorandum

After completion of Phase I investigative activities and analysis, exclusive of Round Two groundwater sampling, data will be reviewed and a Technical Memorandum will be prepared. Analytical results from the source identification/characterization, Round One groundwater quality, and surface water/sediment investigations will be considered in this assessment. The Technical Memorandum will summarize the Remedial Investigation activities performed in Phase I, including:

- A summary of the source identification/characterization study;
- A summary of methods and procedures used in soil gas and surface water/sediment sampling;
- A summary of the monitoring well installation, aquifer testing and water level monitoring programs, and details of the hydraulic conductivity results. Boring logs and well construction details will be included;
- Procedures used for Round One groundwater sampling;
- Results of the field analysis of soil gas and water samples collected during Subtasks 4.3 and 4.4;
- Laboratory analysis results for the Phase I investigation;
- Recommendations for additional data needed at the site;
- An interim site assessment based on the evaluation of Phase I data.

Five copies of the draft Technical Memorandum will be distributed to MDNR. After review of the Technical Memorandum, a meeting will be held to discuss the results of the Phase I investigation, whether additional investigation is warranted and the scope of the additional investigation. If additional investigation is deemed necessary, a Phase II investigation plan will be prepared and incorporated into the RI/FS Work Plan. If no additional investigation is needed, the second round of groundwater quality sampling will be conducted (Subtask 4.6) for comparison to Round 1 results.

TASK 5 - PHASE II INVESTIGATION

The Phase II investigation will focus on data gaps identified in the Phase I Technical Memorandum (Subtask 4.9) and will likely involve additional on-site activities and possible placement of additional monitoring wells. A revision of the RI Work Plan, Budget and Schedule to detail the Phase II activities will be necessary. These revisions will include additional data needed to characterize the nature and extent of the problem and to include data potentially needed to evaluate and design remedial actions. The Sampling Plan and the Health and Safety Plan will be updated as described in Subtasks 2.3 and 2.4. and Health and Safety Plan.

If determined necessary by MDNR and EPA, pilot, bench scale and/or treatability studies will be planned and conducted to determine the applicability of remedial technologies to site-specific conditions or problems. This will include the development of a testing plan to identify the type(s) of study needed, the level of effort required, and data management and interpretation guidelines. It will also entail vendor, test facility and/or equipment procurement, and equipment operation and testing. Upon completion of testing, analysis of results will be performed to assess the technology. The testing program will be summarized in the Feasibility Study Report. An addendum to the Work Plan and a revised budget and schedule will be prepared for the treatability study/pilot testing and submitted to MDNR and U.S. EPA.

TASK 6 - COMMUNITY RELATIONS

Community relation activities are the primary responsibility of MDNR and U.S. EPA. Costs included in Table 1 for support activities supplied by Warzyn include:

- Analysis of community attitudes toward proposed actions;
- Attendance at two meetings such as briefings, press conferences, workshops, and public and other informal meetings;
- Preparation of limited slides or visusal displays in community meetings, public hearings, project review meetings, and other meetings.

TASK 7 - REMEDIAL INVESTIGATION REPORT

A Remedial Investigation (RI) Report will be prepared to summarize and evaluate the data collected during the site investigation (Tasks 3, 4 and 5) and as part of the initial investigation activities (Task 1). The primary emphasis of the RI Report will be to delineate sources and extent of released hazardous constituents. The report will address site conditions based upon the media and area investigated. It is anticipated the identifiable media and areas will be:

- Subsoils
- Surface Water
- Sediment
- Groundwater
- Identified source areas

The nature and extent of the releases in each media and area as characterized by the investigation will be discussed in the report. The character of the releases with respect to known or potential threats to the public health, welfare or the environment will be identified. An assessment as to the significance of any observed or potential releases will be made.

The RI will include development of the preliminary groundwater flow model into a flow model matched to existing conditions. A transport model is planned to be used, but will not be calibrated due to the anticipated lack of calibration sufficient data. The flow model will be a quasi 3-D model, while the transport model will be 2-D, simulating the primary aquifer only. The model will be used to help draw conclusions regarding the source(s) and the extent of contamination within the aquifer. The effect of the no action alternative will also be evaluated. The primary use of the model will be in the FS, for evaluation of potential remedial actions on the contaminant distribution within the aquifer.

As part of the RI report, a review of QA/QC procedures followed for the sampling, analysis and data handling aspects of the RI as required by the approved QAPP will be prepared. Any limitations on data usage based on deviations from the QAPP, or from available analytical QA/QC information, will be identified.

The RI Report will consider applicable U.S. EPA guidance documents. The report will be issued as a draft within three months of receipt of the groundwater monitoring data from the last phase of groundwater investigations. The schedule assumes MDNR and U.S. EPA review comments will be available within one month of the receipt of the draft report. The final report will be issued within one month of receipt of agency comments on the draft report.

The probable cost for this task was developed based upon the following assumptions:

- Five copies of the draft report will be issued to the MDNR. The report is assumed to be 100 pages long with 20 drawings.
- Revisions to the report will be made based on the MDNR comments. The comments from MDNR are assumed to be compiled by MDNR so that Warzyn receives one set of comments and revisions.
- Five copies of the final report will be submitted to both MDNR and U.S. EPA. The report is assumed to be of similar size and composition to the draft report.
- One meeting between representatives of Warzyn, MDNR and U.S EPA will be held at MDNR offices in Lansing to discuss review comments.

Warzyn and EI will prepare the RI report.

TASK 8 - RI PROJECT MANAGEMENT

Project management includes the day-to-day management of the project, scheduling of activities, preparation of invoices and other administrative duties on the project. Included within this task are Warzyn's internal quality assurance/ quality control review procedures. It also includes monthly project progress summaries and biweekly contacts with the MDNR project manager. Invoices will also be submitted monthly to MDNR. Warzyn will provide the RI Project Management.

FEASIBILITY STUDY (FS)

TASK 9 - WORK PLAN REVISION AND DESCRIPTION OF PROPOSED RESPONSE

Prior to the completion of the RI, an updated Work Plan for the FS will be drafted. The Work Plan will outline a revised budget and schedule for FS completion based on information gained in Phase I and Phase II (if conducted) of the RI. Costs prepared for this Work Plan assume that a single source and discrete plume of TCE and/or PCE is identified through the RI. Consideration of additional compounds or source areas in this FS would be considered out of scope. The approved updated Work Plan will be used to direct the remainder of the study. Updated U.S. EPA FS guidances and policies will be referenced in the updated FS Work Plan. A draft FS Work Plan will be submitted to MDNR for the appropriate agency reviews. The final revised FS will be based on one set of comments compiled by the MDNR.

A site-specific statement of purpose for the response, based on the results of the remedial investigation, will be presented. The statement will identify the actual or potential exposure pathways that should be addressed by remedial alternatives. Information on the site background, the nature and extent of the problem, and previous response activities presented in Task 1 of the remedial investigation may be incorporated by reference.

TASK 10 - EXPOSURE ASSESSMENT

Based on the results of the remedial investigation, an Exposure Assessment will be prepared. The Exposure Assessment will be incorporated into the FS. U.S. EPA guidance on Risk Assessment and Management, and the Superfund Public Health Evaluation Manual, will be referenced in developing the assessment.

TASK 11 - PRELIMINARY REMEDIAL TECHNOLOGIES

A master list of potentially feasible technologies will be developed based on the site-specific problems and statement of purpose identified in Task 9. The master list will be screened considering site conditions, contaminant characteristics, and technical requirements, to eliminate or modify those technologies that may prove extremely difficult to implement, will require unreasonable time periods, or will rely on inappropriate technology. Screening will be done in consultation with U.S. EPA and MDNR.

TASK 12 - DEVELOPMENT OF ALTERNATIVES

Based on the results of the remedial investigation and consideration of preliminary remedial technologies (Task 10), a limited number of alternatives will be developed, based on the objectives established for the response.

Subtask 12.1 - Establishment of Remedial Response Objectives

Site-specific objectives for the response will be established. These objectives will be based on:

- public health and environmental concerns;
- the description of the current situation (from Task 1);
- information gathered during the remedial investigation;
- the requirements of Section 121 of the Superfund Amendments and Reauthorization Act (SARA) of 1986;
- Section 300.68 of the National Contingency Plan (NCP);
- U.S. EPA's interim guidance, and the requirements of any other applicable U.S. EPA, Federal, and MDNR environmental standards; and
- guidance and advisories as defined under U.S. EPA's CERCLA compliance policy compendium of May 9, 1985.

Objectives for management of migration measures will be to prevent or minimize impacts of contamination that have migrated from the site. Preliminary cleanup objectives will be developed in consultation with U.S. EPA and the MDNR.

Subtask 12.2 - Identification of Remedial Alternatives

Alternatives will be developed to incorporate remedial technologies (from Task 10), response objectives, and other appropriate considerations into a comprehensive, site-specific approach. According to Section 300.68(k) of the NCP, to the extent possible and appropriate, at least one of each of the following types of remedial alternatives shall be developed as part of the FS:

- Alternatives for treatment or disposal at an off-site facility, as appropriate;
- Alternatives that attain applicable or relevant and appropriate Federal public health and environmental requirements;
- As appropriate, alternatives that exceed applicable or relevant and appropriate Federal public health and environmental requirements;
- As appropriate, alternatives that do not attain applicable or relevant and appropriate Federal public health and environmental requirements, but will reduce the likelihood of present or future threat from hazardous substances and that provide significant protection to public health and welfare and the environment. This must include an alternative that closely approaches the level of protection provided by the applicable or relevant and appropriate requirements; and,
- No action alternative.

There may be overlap among the alternatives developed. Further, alternatives outside of these categories may also be developed. The alternatives will be developed in close consultation with U.S. EPA and MDNR. The rationale for excluding any technologies identified in Task 11 will be documented.

In developing remedial alternatives, an effort will be made to develop alternatives which utilize permanent solutions and alternative treatment technologies. An assessment of such technologies will be made in the FS. Section 121 of SARA states a clear preference for these types of alternatives, and makes the statement that off-site transport and disposal of hazardous substances without such treatment is the least favored alternative remedial action. Section 121 of the SARA also states that these types of of alternatives can be selected even if they have not been demonstrated at other facilities or sites with similar characteristics.

TASK 13 - INITIAL SCREENING OF ALTERNATIVES

Prior to undertaking detailed evaluations of the remaining alternatives, the alternatives developed in Task 12 will be screened to eliminate those that are clearly infeasible or inappropriate. Three broad considerations will be used as a basis for the initial screening: cost, acceptable engineering practice, and effectiveness. The following factors will be considered:

1. Effectiveness

Those alternatives that satisfy the response objectives and contribute substantially to the protection of public health, welfare, or the environment will be considered further. Source control alternatives will achieve adequate control of source materials. Management of migration alternatives will minimize or mitigate the threat of harm to public health, welfare, or the environment. Alternatives posing significant adverse environmental effects will be excluded.

2. Acceptable Engineering Practices

Alternatives which are feasible for the location and conditions of the release that are applicable to the problem, and which represent a reliable means of addressing the problem will be considered further.

3. Cost

An alternative whose cost far exceeds that of other alternatives will usually be eliminated unless other significant benefits may also be realized. Total costs will include the costs of implementing the alternatives and cost of short- and long-term operations and maintenance.

The cost screening will be conducted only after the effectiveness and acceptable engineering practice screenings have been performed.

Following initial screening, an alternatives array document shall be developed to outline remaining alternatives. This shall be in the form of a deliverable and shall facilitate identification of Federal and State ARARs for incorporation into the detailed alternatives analysis.

TASK 14 - DETAILED ANALYSIS OF THE ALTERNATIVES

The cost-effectiveness of alternative remedies that pass through the initial screening will be evaluated in detail, using the following guide:

Subtask 14.1 - Technical Analysis

The Technical Analysis will:

1. Describe appropriate treatment, storage, and disposal technologies,

2. Discuss how the alternative does (or does not) comply with specific requirements of other environmental programs. When an alternative does not comply, discuss how the alternative prevents or minimizes the migration of contaminants and public health or environmental impacts and describe special design needs that could be implemented to achieve compliance.

3. Outline operation, maintenance, and monitoring requirements of the remedy,

4. Identify and review potential off-site facilities to ensure compliance with applicable RCRA and other U.S. EPA environmental program requirements, both current and proposed. Potential disposal facilities should be evaluated to determine whether off-site management of site wastes could result in a potential for a future release from the disposal facility,

5. Identify temporary storage requirements, off-site disposal needs, and transportation plans,

6. Describe whether the alternative results in permanent treatment or destruction of the contaminant, and, if not, the potential for future release to the environment,

7. Outline safety requirements for remedial implementation (including both on-site and off-site health and safety considerations),

8. Describe how the alternative could be phased into individual operable units. The description should include a discussion of how various operable units of the total remedy could be implemented individually or in groups, resulting in a significant improvement to the environment or savings in cost,

9. Describe how the alternative could be segmented into areas to allow implementation in differing phases, and describe special engineering requirements of the remedy or site preparation considerations.

10. Evaluate engineering implementation, reliability and constructability.

Subtask 14.2 - Environmental Assessment

An Environmental Assessment (EA) will be performed for each alternative. The EA should focus on the site problems and pathways of contamination addressed by each alternative. The EA for each alternative will include, at a minimum, an evaluation of beneficial effects of the response/adverse effects of the response, and an analysis of measures to mitigate adverse effects. The no-action alternative will be evaluated to describe the current site situation and anticipated environmental conditions, if no actions are taken. The no-action alternative will serve as the baseline for the analysis.

Subtask 14.3 - Public Health Analysis

Each alternative will be assessed in terms of the extent to which it mitigates long-term exposure to residual contamination and protects public health, both during and after completion of the remedial action. The assessment will describe the levels and characterizations of contaminants on-site, and the potential exposure routes. The effect of "no-action" will be described in terms of short-term effects, long-term exposure to hazardous substances, and resulting public health impacts. Each remedial alternative will be evaluated to determine the level of exposure to contaminants and the reduction in exposure over time. The relative reduction in impact will be determined by comparing residual levels of each alternative with existing criteria, standards, or guidelines acceptable to U.S. EPA. For source control measures should be based on the relative effectiveness of technologies. The no-action alternative will serve as the baseline for the analysis.

Subtask 14.4 - Institutional Analysis

Each alternative will be evaluated based on relevant institutional needs. Specifically, regulatory requirements, permits, community relations, and participating agency coordination will be assessed.

Subtask 14.5 - Cost Analysis

The cost of each feasible remedial action alternative (and each phase or segment of the alternative) will be evaluated. The cost will be presented as a present worth cost and will include the total cost of implementing the alternative and the annual operating and maintenance costs. Both monetary costs and associated non-monetary costs will be included. A distribution of costs over time will be provided.

TASK 15 - EVALUATION OF COST-EFFECTIVE ALTERNATIVE

The U.S. EPA and MDNR will review the results of the detailed evaluation of the remedial alternatives prepared under Task 14. In recommending the appropriate extent of remedy from among alternatives which achieve adequate protection of public health and the environment, the following factors will be considered: cost, technology, reliability, and administrative concerns. The expectation for the selected remedy is that it will attain or exceed applicable or relevant and appropriate public health and environmental requirements.

At a minimum, the following seven items will be provided to allow a comparison of alternatives:

1. Present Worth of Total Costs

The net present value of capital and operating and maintenance costs will be presented.

2. Health Information

For the no-action alternative, a quantitative statement including a range estimate of maximum individual risk will be provided. Where quantification is not possible, a qualitative analysis may be used. For source control options, a quantitative risk assessment will not be provided. For management of migration measures, a quantitative risk assessment (including a range estimate of maximum individual risks) will be supplied.

3. Environmental Effects

The most important effects or impacts will be summarized. Reference will be made to supplemental information arrayed in a separate table, if necessary.

4. Technical Aspects of the Remedial Alternatives

The technical aspects of each remedial alternative relative to the others will be clearly delineated. Such information generally will be based on the professional opinion and the technologies comprising the remedial alternative.

5. Information on the Extent to Which Remedial Alternatives Meet the Technical Requirements and Environmental Standards of Applicable Environmental Regulations

This information will be arrayed so that differences in how remedial alternatives satisfy such standards are readily apparent.

6. Information on Community Effects

The extent to which implementation of a remedial alternative disrupts the community (e.g., traffic, temporary health risks, and relocation) will be identified and discussed.

7. Other Factors

Institutional factors that may inhibit implementing a remedial alternative, and other site-specific factors identified in the course of the detailed analysis that may influence alternative selection, will be discussed.

TASK 16 - PRELIMINARY REPORT

A preliminary FS report will be prepared presenting the results of Tasks 8 through 15, and including supplemental information in appendices. Five copies will be submitted to the MDNR Project Manager who will distribute them to appropriate agencies for review. The U.S. EPA, MDPH and the City will provide MDNR with comments which will be compiled and sent to Warzyn to be considered in the final FS Report.

TASK 17 - FINAL FS REPORT

A final FS report will be prepared for submission to U.S. EPA. The report will incorporate comments and additions as received on the preliminary FS report. This report will include a responsiveness summary on public comments received. Six copies will be submitted to the MDNR Project Manager who will distribute them to the U.S. EPA.

REFERENCES CITED

Western Michigan University, 1981, Hydrogeologic Atlas of Michigan: Department of Geology, College of Arts and Sciences, Western Michigan University, Kalamzoo, Michigan, 35 plates.

Gove Associates, Inc. 1982, City of Sturgis Preliminary Investigation of Trichloroethylene Contamination: Gove Assoc. Project 8917-TCE, 42 p.

TechLaw Inc., 1984, Final Report Sturgis Municipal Wells: EPA Contract No. 68-01-6769, Work Assignment No. 84-160, GCA Number 84-160-001-54, 17 p.

[cmj-37-1]

PROJECT ORGANIZATION CHART
STURGIS

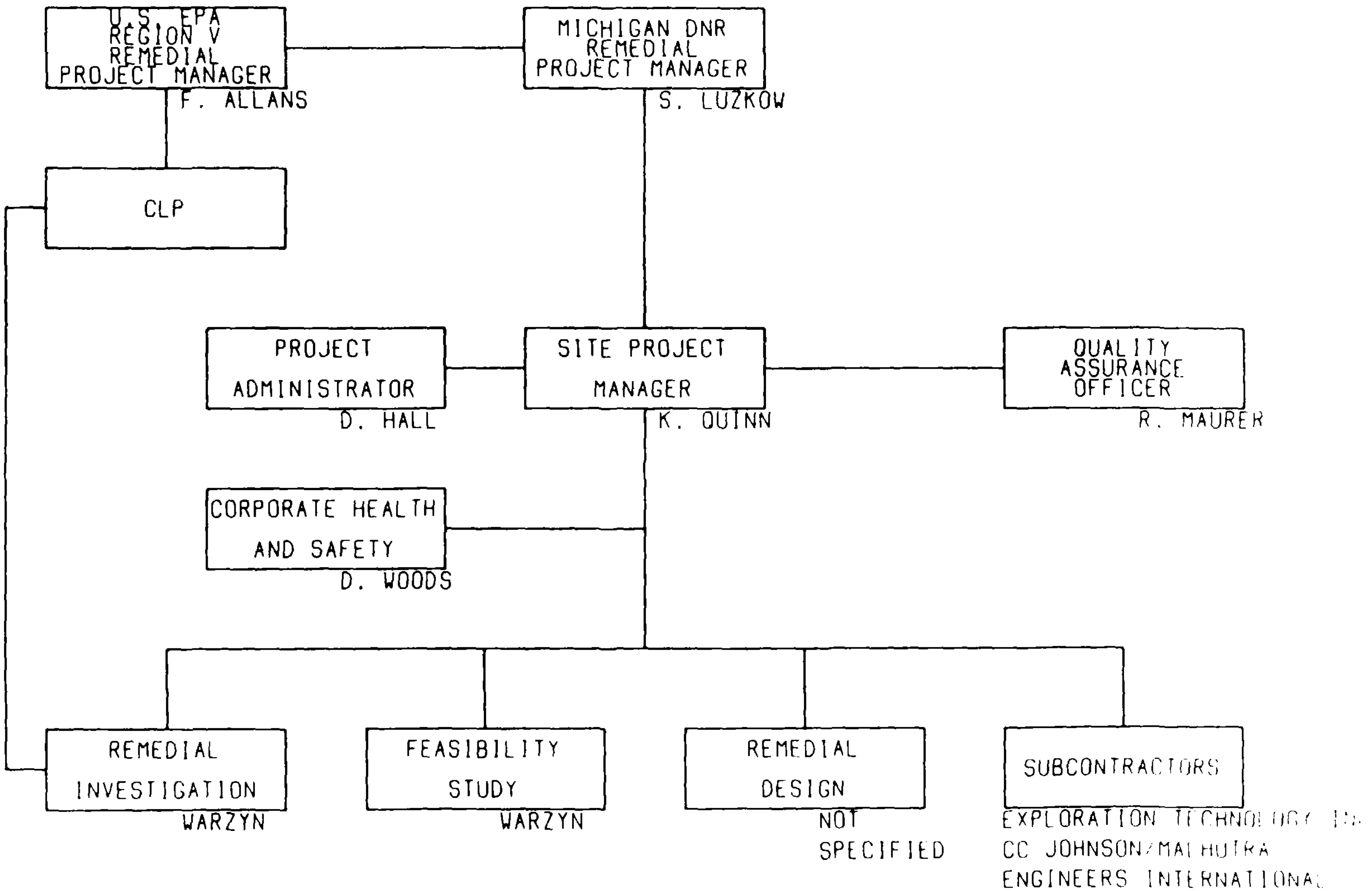


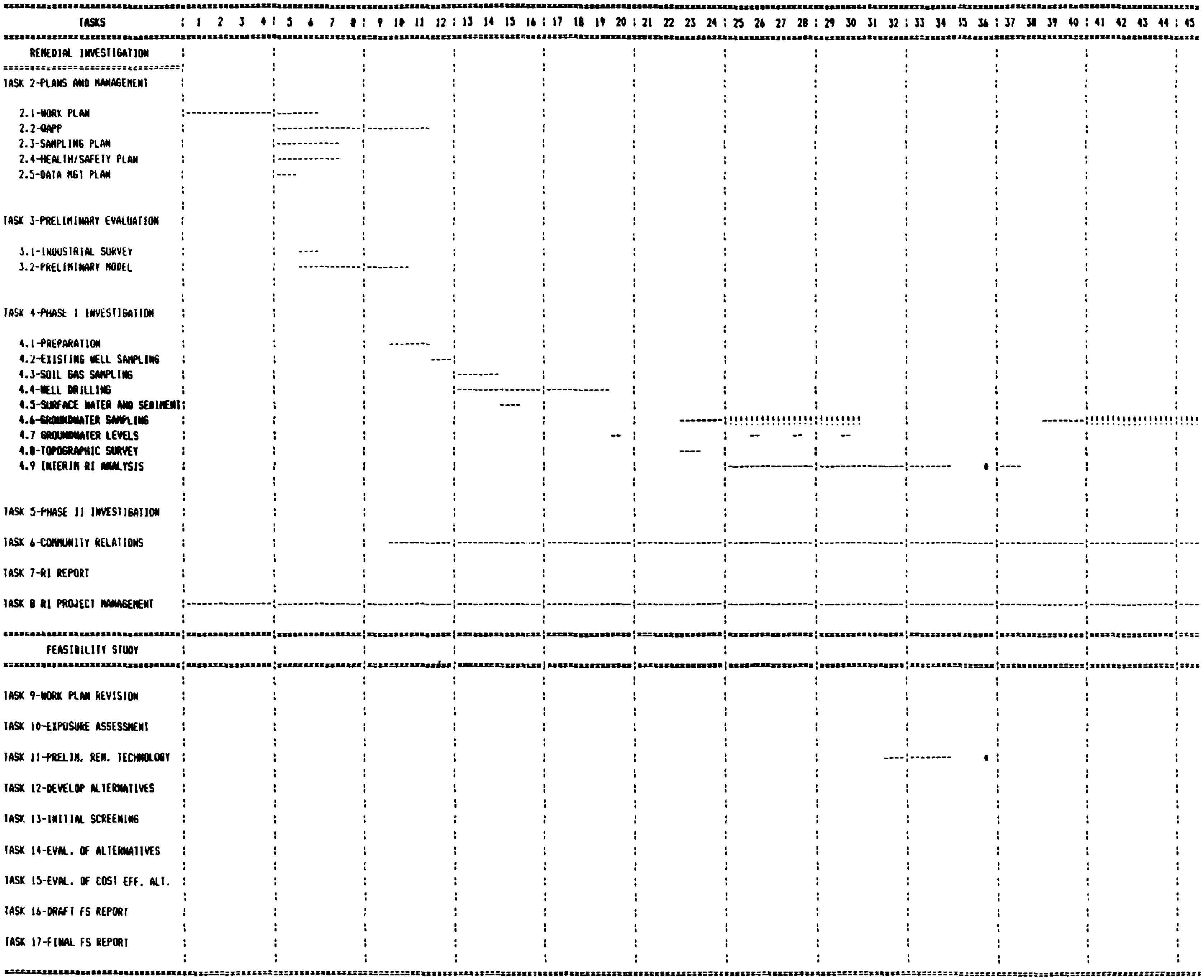
TABLE 1
COST ESTIMATES
REMEDIAL INVESTIGATION WORK PLAN

		TASK 2 DEVELOP PLANS	TASK 3.1 INDUST. SURVEY	TASK 3.2 PRELIM. MODELING	TASK 4.1 SITE OFFC SET UP	TASK 4.2 EXIST. WELL SAMPLING	TASK 4.3 SOIL GAS SAMPLING	TASK 4.4 WELL DRILLING	TASK 4.5 SW AND SED INVEST.	TASK 4.6 GW SAMPLING K TESTS	TASK 4.7 WATER LEVELS	TASK 4.8 TOPO SURVEY	TASK 4.9 RI ANALYSIS TECH MEMO	TASK 5 PHASE II INVEST.	TASK 6 COMMUNITY RELATIONS	TASK 7 RI REPORT	SUBTASK 7.1 DATA VALIDATION	TASK 8 RI PROJ MGT	RI TOTAL
Labor (hrs)																			
P4		48	2	6									4			24		244	328
P3		330	24	80	6			360		12	3	4	30		20	70	88	289	1316
P2		200		80	30								20			300		70	700
P1		40	35	200	60	60	136	350		256	8		80		30	420	350	60	2085
T2									24			10	20			20		20	94
T1				20									60		24	60			164
OFFICE		48	8	10									32			48		144	290
TOTAL LABOR		666	69	396	96	60	136	710	24	268	11	14	246	0	74	942	438	827	4977
P4	$30.51	$1,464	$61	$183	$0	$0	$0	$0	$0	$0	$0	$0	$122	$0	$0	$732	$0	$7,444	$10,007
P3	$23.64	$7,801	$567	$1,891	$142	$0	$0	$8,510	$0	$284	$71	$95	$709	$0	$473	$1,655	$2,080	$6,832	$31,110
P2	$18.47	$3,694	$0	$1,478	$554	$0	$0	$0	$0	$0	$0	$0	$369	$0	$0	$5,541	$0	$1,293	$12,929
P1	$13.72	$549	$480	$2,744	$823	$823	$1,866	$4,802	$0	$3,512	$110	$0	$1,098	$0	$412	$5,762	$4,802	$823	$28,606
T2	$10.10	$0	$0	$0	$0	$0	$0	$0	$242	$0	$0	$101	$202	$0	$0	$202	$0	$202	$949
T1	$8.43	$0	$0	$169	$0	$0	$0	$0	$0	$0	$0	$0	$506	$0	$202	$506	$0	$0	$1,383
OFFICE	$7.61	$365	$61	$76	$0	$0	$0	$0	$0	$0	$0	$0	$244	$0	$0	$365	$0	$1,096	$2,207
Total Dir Labor Cost		$13,874	$1,169	$6,541	$1,519	$823	$1,866	$13,312	$242	$3,796	$181	$196	$3,250	$0	$1,087	$14,764	$6,882	$17,690	$87,192
Direct Labor Overhead	0.46	$6,382	$538	$3,009	$699	$379	$858	$6,124	$112	$1,746	$83	$90	$1,495	$0	$500	$6,791	$3,166	$8,138	$40,108
G&A Overhead	1.15	$15,955	$1,345	$7,522	$1,747	$947	$2,146	$15,309	$279	$4,365	$208	$225	$3,737	$0	$1,250	$16,978	$7,915	$20,344	$100,270
TOTAL LABOR COST		$34,211	$3,052	$17,071	$3,965	$2,149	$4,870	$34,745	$633	$9,908	$472	$510	$8,481	$0	$2,836	$38,533	$17,963	$46,172	$227,570
Expense Item																			
transportation		$700	$865		$250	$570	$955	$6,600	$55	$900			$1,105		$755	$755			$13,510
subsistence		$360	$180		$810	$360	$1,710	$8,640	$90	$1,620			$270		$180	$180			$14,400
total ODC						$473	$1,633	$9,515	$129	$3,348			$1,000					$1,500	$17,598
analytical lab						$2,550	$7,650	$15,300											$25,500
special equipment				$2,850	$5,500		$2,350	$6,060	$200	$5,400									$22,360
TOTAL EXPENSE COST		$1,060	$1,045	$2,850	$6,560	$3,953	$14,298	$46,115	$474	$11,268	$0	$0	$2,375	$0	$935	$935	$0	$1,500	$93,368
Subcontracts																			
KMA						$13,413	$7,507		$1,279	$50,040	$5,674	$6,339	$1,262					$1,710	$87,224
ENG. INTERN.						$2,312		$68,065		$9,135			$1,950			$1,280		$1,344	$84,086
ETI								$154,790											$154,790
LAB																			$0
TOTAL SUBCONTRACTS COST		$0	$0	$0	$0	$15,725	$7,507	$222,855	$1,279	$59,175	$5,674	$6,339	$3,212	$0	$0	$1,280	$0	$3,054	$326,100
Fee																			
Labor	0.10	$3,621	$305	$1,707	$396	$215	$487	$3,475	$63	$991	$47	$51	$848	$0	$284	$3,853	$1,796	$4,617	$22,757
Expense	0.10	$106	$105	$285	$656	$395	$1,430	$4,612	$47	$1,127	$0	$0	$238	$0	$94	$94	$0	$150	$9,337
Subcon.	0.05	$0	$0	$0	$0	$786	$375	$11,143	$64	$2,959	$284	$317	$161	$0	$0	$64	$0	$153	$16,305
TOTAL FEE		$3,727	$410	$1,992	$1,052	$1,396	$2,292	$19,229	$175	$5,076	$331	$368	$1,246	$0	$377	$4,011	$1,796	$4,920	$48,399
TOTAL EST. SUBTASK COST		$40,998	$4,507	$21,913	$11,577	$23,223	$28,967	$322,944	$2,560	$85,427	$6,476	$7,217	$15,315	$0	$4,148	$44,759	$19,759	$55,646	$695,437

TABLE 1
CONTINUED
COST ESTIMATE
FEASIBILITY STUDY

		TASK 9 WORK PLAN REV PROP.RESPONSE	TASK 10 EXPOSURE ASSESSMENT	TASK 11 PRELIMINARY REMEDIAL TECH	TASK 12 DEVELOP ALTER	TASK 13 SCREEN ALTER	TASK 14 ANALYZE ALTER	TASK 15 EVAL COST EFF ALTER	TASK 16 PRELIM FS REPORT	TASK 16 FINAL FS REPORT	TASK 17 FS PROJ MGT	FS TOTAL	PROJECT TOTAL
Labor (hrs)													
P4		10	30	10	48	10	24	8	30	20	136	326	654
P3		32	120	20	90	60	48	12	80	16	131	609	1925
P2		20	80	120	120	80	160	40	100	20	20	760	1460
P1		20	60	80	80	40	80	0	30	0	12	402	2487
T2		0	40	0	80	20	40	10	90	16	10	306	400
T1		0	0	0	0	0	0	0	0	0	0	0	164
OFFICE		10	20	20	60	30	20	0	40	24	80	304	594
TOTAL LABOR		92	350	250	478	240	372	70	370	96	389	2707	7684
P4	$30.51	$305	$915	$305	$1,464	$305	$732	$244	$915	$610	$4,149	$9,946	$19,954
P3	$23.64	$756	$2,837	$473	$2,128	$1,418	$1,135	$284	$1,891	$378	$3,097	$14,397	$45,507
P2	$18.47	$369	$1,478	$2,216	$2,216	$1,478	$2,955	$739	$1,847	$369	$369	$14,037	$26,966
P1	$13.72	$274	$823	$1,098	$1,098	$549	$1,098	$0	$412	$0	$165	$5,515	$34,122
T2	$10.10	$0	$404	$0	$808	$202	$404	$101	$909	$162	$101	$3,091	$4,040
T1	$8.43	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,383
OFFICE	$7.61	$76	$152	$152	$457	$228	$152	$0	$304	$183	$609	$2,313	$4,520
Total Dir Labor Cost		$1,781	$6,609	$4,244	$8,171	$4,180	$6,476	$1,368	$6,279	$1,702	$8,490	$49,300	$136,491
Direct Labor Overhead	0.46	$819	$3,040	$1,952	$3,759	$1,923	$2,979	$629	$2,888	$783	$3,905	$22,678	$62,786
G&A Overhead	1.15	$2,049	$7,600	$4,881	$9,396	$4,807	$7,447	$1,573	$7,220	$1,957	$9,764	$56,695	$156,965
TOTAL LABOR COST		$4,650	$17,250	$11,077	$21,325	$10,910	$16,902	$3,569	$16,387	$4,442	$22,159	$128,672	$356,242
Expense Item													
transportation			$700		$1,620				$700			$3,020	$16,530
subsistence			$180		$300				$180			$660	$15,060
total ODC			$100		$400	$300			$1,000	$1,200	$1,000	$4,000	$21,598
analytical lab												$0	$25,500
special equipment		$204					$450					$654	$23,014
TOTAL EXPENSE COST		$204	$980	$0	$2,320	$300	$450	$0	$1,880	$1,200	$1,000	$8,334	$101,702
Subcontracts													
KMA												$0	$87,224
ENG. INTERN.												$0	$84,086
EII												$0	$154,790
LAB												$0	$0
TOTAL SUBCONTRACTS COST		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$326,100
Fee													
Labor	0.10	$465	$1,725	$1,108	$2,133	$1,091	$1,690	$357	$1,639	$444	$2,216	$12,867	$35,624
Expense	0.10	$20	$98	$0	$232	$30	$45	$0	$186	$120	$100	$833	$10,170
Subcon.	0.05	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$16,305
TOTAL FEE		$485	$1,823	$1,108	$2,365	$1,121	$1,735	$357	$1,827	$564	$2,316	$13,701	$62,099
TOTAL EST. SUBTASK COST		$5,339	$20,053	$12,185	$26,010	$12,331	$19,087	$3,926	$20,094	$6,207	$25,475	$150,707	$846,144

TABLE 2
PROJECT SCHEDULE
STURGIS WELL FIELD RI/FS

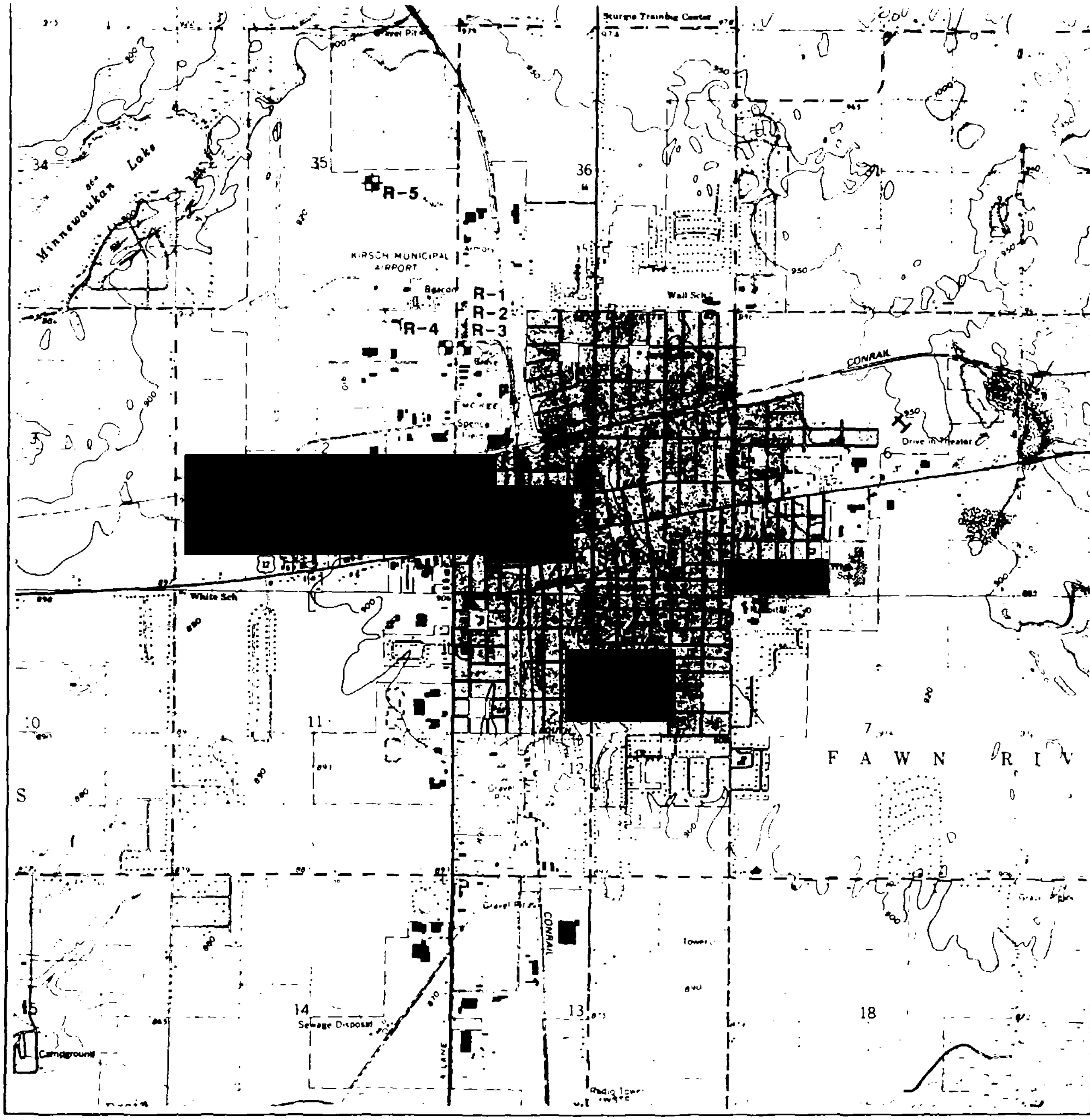


---- - PROJECT ACTIVITIES
!!!! - LAB TURNAROUND TIME
* - MEETING

PROJECT SCHEDULE
IS WELL FIELD RI/FS

TASKS	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
REMEDIAL INVESTIGATION																																			
TASK 2-PLANS AND MANAGEMENT																																			
2.1-WORK PLAN																																			
2.2-QAPP																																			
2.3-SAMPLING PLAN																																			
2.4-HEALTH/SAFETY PLAN																																			
2.5-DATA MGT PLAN																																			
TASK 3-PRELIMINARY EVALUATION																																			
3.1-INDUSTRIAL SURVEY																																			
3.2-PRELIMINARY MODEL																																			
TASK 4-PHASE I INVESTIGATION																																			
4.1-PREPARATION																																			
4.2-EXISTING WELL SAMPLING																																			
4.3-SOIL GAS SAMPLING																																			
4.4-WELL DRILLING																																			
4.5-SURFACE WATER AND SEDIMENT																																			
4.6-GROUNDWATER SAMPLING	!!!!																																		
4.7 GROUNDWATER LEVELS																																			
4.8-TOPOGRAPHIC SURVEY																																			
4.9 INTERIM RI ANALYSIS																																			
TASK 5-PHASE II INVESTIGATION																																			
TASK 6-COMMUNITY RELATIONS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TASK 7-RI REPORT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-						*	-	-	-							
TASK 8 RI PROJECT MANAGEMENT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-											
FEASIBILITY STUDY																																			
TASK 9-WORK PLAN REVISION								-	-	-		*																							
TASK 10-EXPOSURE ASSESSMENT													-	-	-	-	-	-	-		*														
TASK 11-PRELIM. REM. TECHNOLOGY																-	-	-	-																
TASK 12-DEVELOP ALTERNATIVES																	-	-	-	-															
TASK 13-INITIAL SCREENING																			-	-															
TASK 14-EVAL. OF ALTERNATIVES																				-	-	-	-	-											
TASK 15-EVAL. OF COST EFF. ALT.																									-	-	-								
TASK 16-DRAFT FS REPORT																				-	-	-	-	-	-	-	-	-	-	-	-	*			
TASK 17-FINAL FS REPORT																																-	-	-	-

---- - PROJECT ACTIVITIES
!!!! - LAB TURNAROUND TIME
* - MEETING

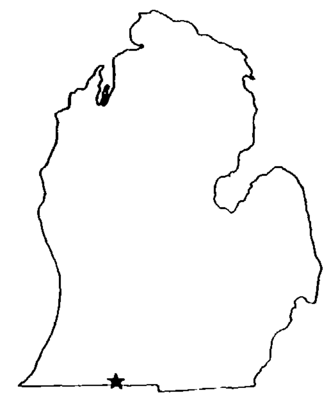


NOTES:

1. SITE LOCATION MAP OBTAINED FROM U.S.G.S. 7 1/2 MINUTE QUADRANGLE MAP STURGIS, MICHIGAN - INDIANA DATED 1961 PHOTOREVISED 1982.
2. CONTOURS INTERVAL IS 10 FEET
3. REFER TO STANDARD U.S.G.S. MAP SYMBOLS.
4. R SERIES WELLS - INDRUSTRIAL WATER SUPPLY WELLS. PW-1 - JACKSON WELL. PW-2 - LAYNE WELL PW-3 - KIRSCH WELL. PW-4 - LAKEVIEW WELL. PW-5 - OAKLAWN WELL.

LEGEND:

APPROXIMATE PUMPING WELL LOCATIONS



north

FIG. :

WARZYN

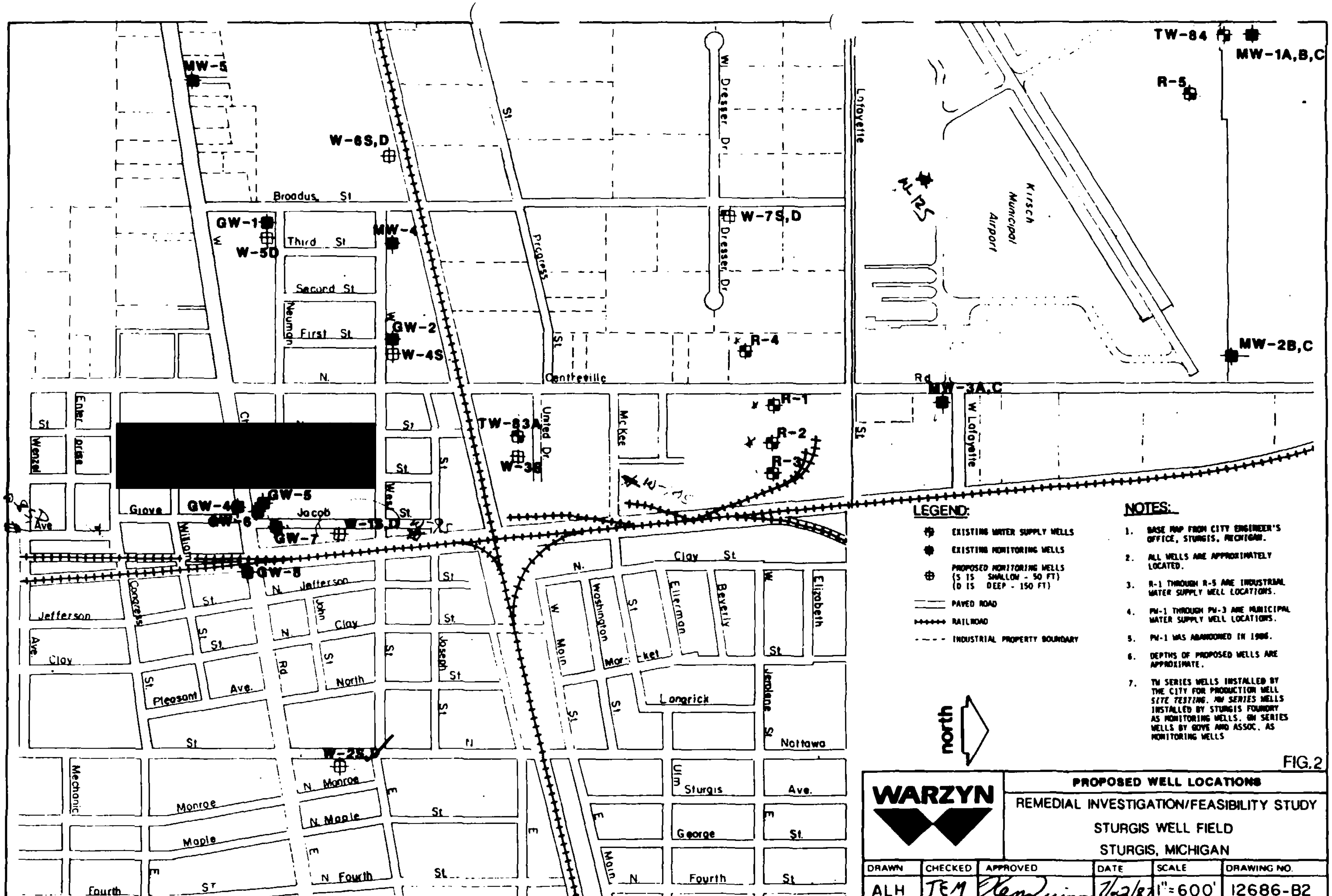
SITE LOCATION MAP

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

STURGIS WELL FIELD

STURGIS, MICHIGAN

DRAWN	CHECKED	APPROVED	DATE	SCALE	DRAWING NO
ALH	TEM	Ken Quinn	7/22/8?	1"=2000'	12686-B1



LEGEND:

- EXISTING WATER SUPPLY WELLS
- EXISTING MONITORING WELLS
- PROPOSED MONITORING WELLS (S IS SHALLOW - 50 FT) (D IS DEEP - 150 FT)
- PAVED ROAD
- RAILROAD
- INDUSTRIAL PROPERTY BOUNDARY

NOTES:

1. BASE MAP FROM CITY ENGINEER'S OFFICE, STURGIS, MICHIGAN.
2. ALL WELLS ARE APPROXIMATELY LOCATED.
3. R-1 THROUGH R-5 ARE INDUSTRIAL WATER SUPPLY WELL LOCATIONS.
4. PW-1 THROUGH PW-3 ARE MUNICIPAL WATER SUPPLY WELL LOCATIONS.
5. PW-1 WAS ABANDONED IN 1986.
6. DEPTHS OF PROPOSED WELLS ARE APPROXIMATE.
7. TW SERIES WELLS INSTALLED BY THE CITY FOR PRODUCTION WELL *SITE TESTING*. MW SERIES WELLS INSTALLED BY STURGIS FOUNDRY AS MONITORING WELLS. GW SERIES WELLS BY GOVE AND ASSOC. AS MONITORING WELLS

north

FIG.2

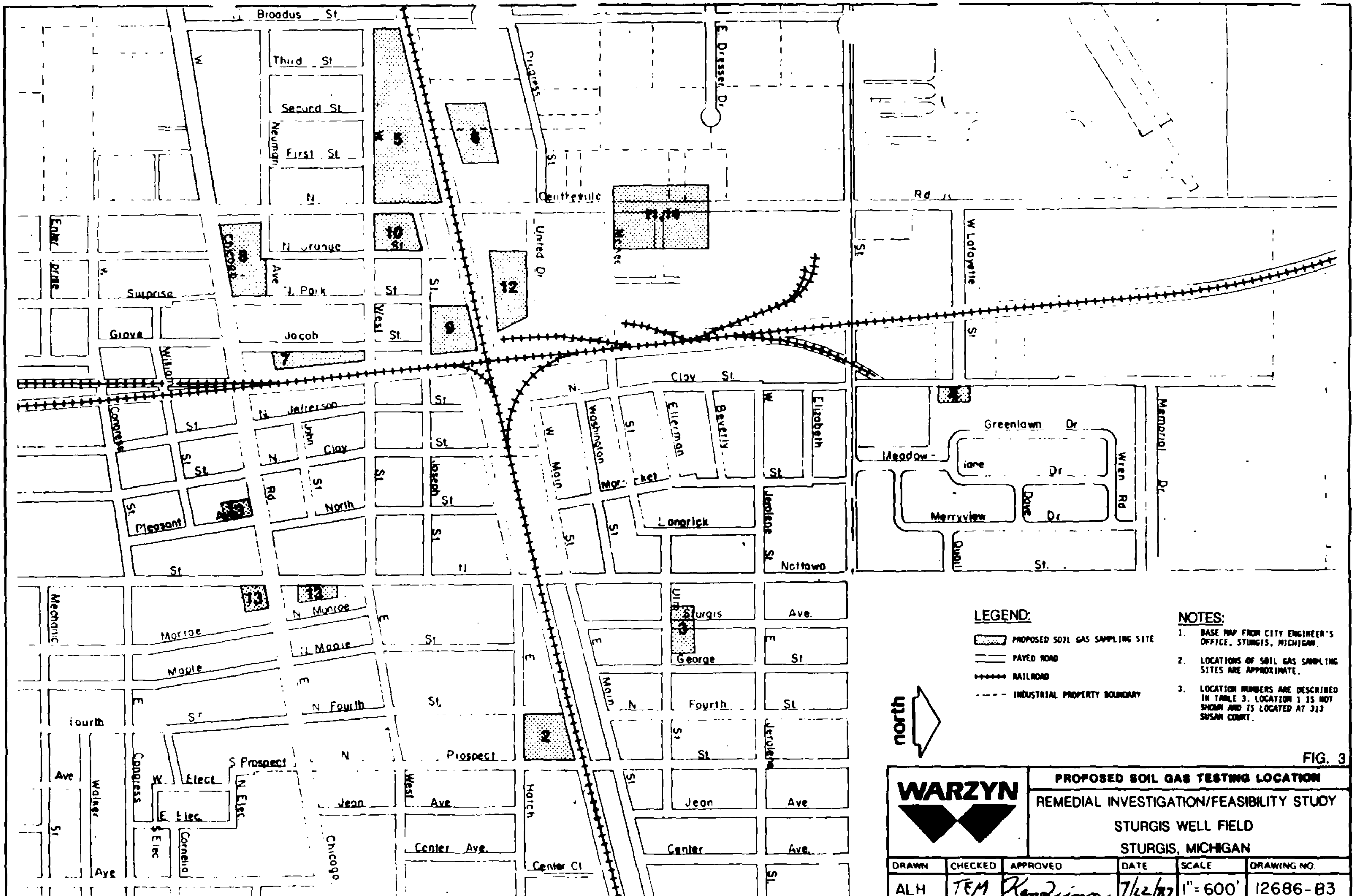
WARZYN

PROPOSED WELL LOCATIONS

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
STURGIS WELL FIELD
STURGIS, MICHIGAN

DRAWN	CHECKED	APPROVED	DATE	SCALE	DRAWING NO.
ALH	TEM	[signature]	7/2/87	1" = 600'	12686-B2

TELEDYNE POST N75474



LEGEND:

- PROPOSED SOIL GAS SAMPLING SITE
- PAVED ROAD
- RAILROAD
- INDUSTRIAL PROPERTY BOUNDARY

NOTES:

1. BASE MAP FROM CITY ENGINEER'S OFFICE, STURGIS, MICHIGAN.
2. LOCATIONS OF SOIL GAS SAMPLING SITES ARE APPROXIMATE.
3. LOCATION NUMBERS ARE DESCRIBED IN TABLE 3. LOCATION 1 IS NOT SHOWN AND IS LOCATED AT 313 SUSAN COURT.

FIG. 3

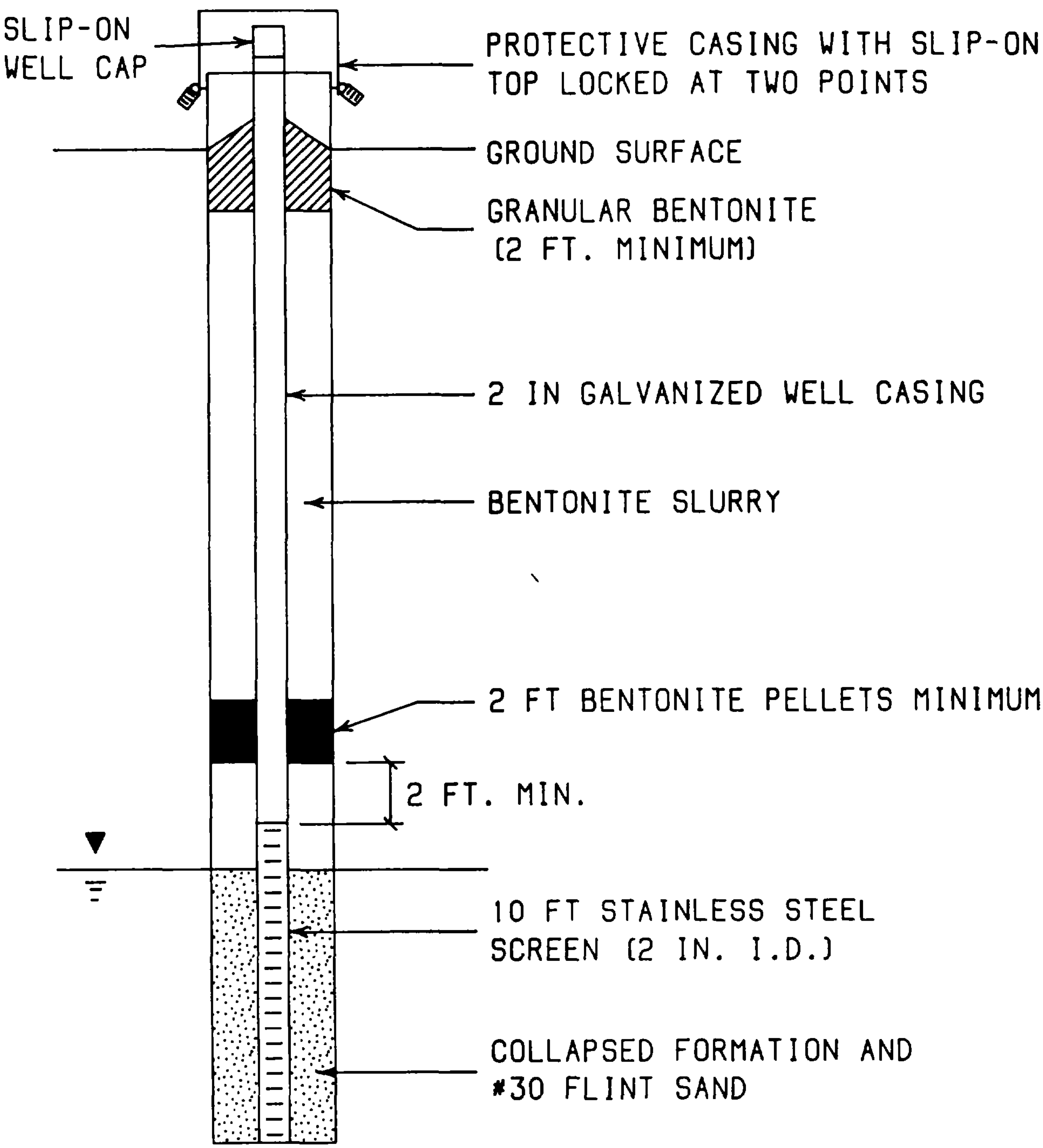
WARZYN

PROPOSED SOIL GAS TESTING LOCATION

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
STURGIS WELL FIELD
STURGIS, MICHIGAN

DRAWN	CHECKED	APPROVED	DATE	SCALE	DRAWING NO.
ALH	TEM	Ken Quinn	7/22/87	1" = 600'	12686-B3

TELEDYNE POST N75674



NOT TO SCALE

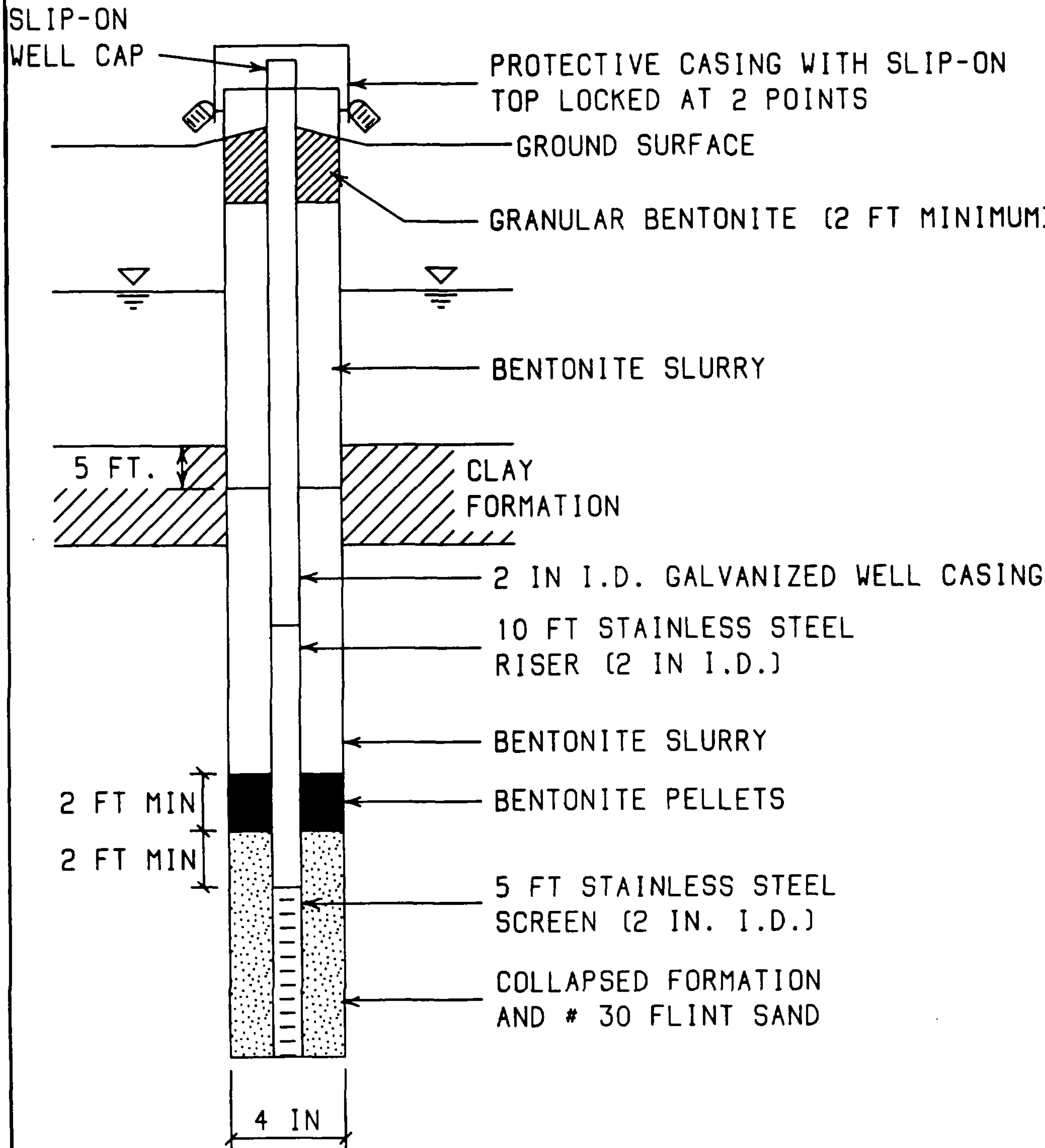
FIG.4

WARZYN ENGINEERING INC

WATER TABLE (SHALLOW) WELL

REMEDIAL INVESTIGATION/FEASIBILTY STUDY.
STURGIS WELL FIELD
STURGIS, MICHIGAN

DWN ALH	CHK'D TEM	APP'D Timothy E. [signature]	DATE 7/22/87	C12686-A1



NOT TO SCALE

FIG.5

WARZYN ENGINEERING INC	DEEP (PIEZOMETER) WELL
	REMEDIAL INVESTIGATION/FEASIBILTY STUDY STURGIS WELL FIELD STURGIS, MICHIGAN

DWN ALH	CHK'D RM	APP'D Timothy E. Mulhol	DATE 7/22/87	C12686-A2

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